UNIVERSITY OF ILLINOIS
Agricultural Experiment Station

SOIL REPORT No. 32

RANDOLPH COUNTY SOILS

By R. S. SMITH, E. E. DeTURK, F. C. BAUER, and L. H. SMITH

URBANA, ILLINOIS, DECEMBER, 1925

The Soil Survey of Illinois was organized under the general supervision of Professor Cyril G. Hopkins, with Professor Jeremiah G. Mosier directly in charge of soil classification and mapping. After working in association on this undertaking for eighteen years, Professor Hopkins died and Professor Mosier followed two years later. The work of these two men enters so intimately into the whole project of the Illinois Soil Survey that it is impossible to disassociate their names from the individual county reports. Therefore recognition is hereby accorded Professors Hopkins and Mosier for their contribution to the work resulting in this publication.

INTRODUCTORY NOTE

It is a matter of common observation that soils vary tremendously in their productive power, depending upon their physical condition, their chemical composition, and their biological activities. For any comprehensive plan of soil improvement looking toward the permanent maintenance of our agricultural lands, a definite knowledge of the various existing kinds or types of soil is a first essential. It is the purpose of a soil survey to classify the various kinds of soil of a given area in such a manner as to permit definite characterization for description and for mapping. With the information that such a survey affords, every farmer or landowner of the surveyed area has at hand the basis for a rational system of improvement of his land. At the same time the Experiment Station is furnished an inventory of the soils of the state, upon which intelligently to base plans for those fundamental investigations so necessary for solving the problems of practical soil improvement.

This county soil report is one of a series reporting the results of the soil survey which, when completed, will cover the state of Illinois. Each county report is intended to be as nearly complete in itself as it is practicable to make it, even at the expense of some repetition. There is presented in the form of an Appendix a general discussion of the important principles of soil fertility, in order to help the farmer and landowner to understand the significance of the data furnished by the soil survey and to make intelligent application of the same in the maintenance and improvement of the land. In many cases it will be of advantage to study the Appendix in advance of the soil report proper.

Data from experiment fields representing the more extensive types of soil, and furnishing valuable information regarding effective practices in soil management, are embodied in the form of a Supplement. This Supplement should be referred to in connection with the descriptions of the respective soil types found in the body of the report.

While the authors must assume the responsibility for the presentation of this report, it should be understood that the material for the report represents the contribution of a considerable number of the present and former members of the Agronomy Department working in their respective lines of soil mapping, soil analysis, and experiment field investigation. In this connection special recognition is due the late Professor J. G. Mosier, under whose direction the soil survey of Randolph county was conducted, and Mr. H. C. Wheeler, who, as leader of the field party, was in direct charge of the mapping.

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SUPPLEMENT

RANDOLPH COUNTY SOILS

By R. S. SMITH, E. E. DeTURK, F. C. BAUER and L. H. SMITH[1]

LOCATION AND CLIMATE OF RANDOLPH COUNTY

Randolph county is located on the Mississippi river about thirty miles south of East St. Louis and covers an area of 593 square miles. The topography varies from flat to undulating over much of the northern and eastern portions, to rough and hilly in a belt two to ten miles wide adjacent to the Mississippi river. Twenty-five percent of the area of the county is mapped as being subject to serious erosion because of its rough topography.

The climate of Randolph county is characterized by a wide range between the temperature extremes of winter and summer. The lowest temperature recorded at Sparta for the years 1910 to 1923 was 18° below zero in 1918, while the highest was 108°, also in 1918. During this period of fourteen years, there were nine winters in which the temperature reached zero or below, and nine summers which registered a temperature of 100° or above. The average date of the last killing frost in spring is April 10; the earliest in fall, October 24. The average length of the growing season is, therefore, 198 days. The shortest growing season recorded was 172 days in 1918; the longest was 232 days in 1922.

The average annual precipitation at Sparta from 1910 to 1923 was 42.03 inches, while at Chester, which is located on the Mississippi river, the average annual precipitation for the period 1911 to 1923 was 44.88 inches, a difference of 2.85 inches. The distribution of rainfall thruout the year is good, as shown by the following monthly averages computed from the Sparta records: January, 3.67 inches; February, 1.93; March, 3.09; April, 4.61; May, 4.58; June, 3.47; July, 2.65; August, 5.37; September, 3.23; October, 4.47; November, 2.20; December, 3.00.

AGRICULTURAL PRODUCTION

Randolph county is primarily agricultural, altho coal mining is an important industry in the county. According to the Fourteenth Census of the United States, there were 2,324 farms in Randolph county in 1919. This number represents a decrease of 211 farms during the preceding ten years. The average size of farm was 139 acres, 106.5 of which were improved. Forty percent of the farms were operated by tenants in 1920, 34 percent in 1909, and 29 percent in 1899.

The following figures show the acreage and production for 1919 of the principal crops grown in the county:

[1] R. S. Smith, in charge of soil survey mapping; E. E. DeTurk, in charge of soil analysis; F. C. Bauer, in charge of experiment fields; L. H. Smith, in charge of publications.

Crops	*Acreage*	*Production*	*Yield per acre*
Corn	31,031	438,165 bu.	14.1 bu.
Oats	13,653	254,317 bu.	18.6 bu.
Wheat	95,263	1,274,026 bu.	13.3 bu.
Timothy	6,582	7,857 tons	1.19 tons
Timonthy and clover mixed	2,063	2,612 tons	1.26 tons
Clover	13,190	16,120 tons	1.22 tons
Alfalfa	1,724	4,249 tons	2.46 tons
Silage crops	2,174	7,968 tons	3.66 tons
Corn for forage	7,469	6,280 tons	.84 tons

The total value of all crops produced in the county for 1919 was estimated at $5,409,708.

It should be borne in mind that the above figures represent the yields of only a single season. A report from the U. S. Department of Agriculture places the yields for four important crops as an average for the ten year period 1911-1920 as follows: corn, 21.3 bushels an acre; oats, 26.6 bushels; hay, 1.11 tons; wheat, 13.2 bushels. Evidently the year 1919, which furnished the Census data, was unfavorable for corn and oats.

The livestock interests are of considerable importance, as shown by the following figures, which are also for the year 1919:

Animals and Animal Products	*Number*	*Value*
Horses	9,196	$ 728,543
Mules	2,881	345,373
Beef cattle	2,698	132,385
Dairy cattle	15,522	721,424
Sheep	2,924	30,276
Swine	19,376	221,207
Chickens and other poultry	235,743	201,750
Chickens and eggs sold	......	1,002,757
Dairy products sold	......	452,694

The total value of livestock and livestock products was $3,836,000. It should be noted that over $1,000,000 was received in 1919 from the sale of chickens and eggs.

Fruit growing is of some importance in Randolph county, and it might be further extended to good advantage. The Census reports that 14,000 quarts of small fruits, 45,000 bushels of apples, and 57,000 pounds of grapes were produced in 1919.

SOIL FORMATION

GEOLOGICAL HISTORY

Much of the material which forms the soils of Randolph county was deposited during the Glacial period. During this period conditions were such that ice accumulated in great masses in the region of Labrador, west of Hudson Bay, and in the Rocky Mountains. The ice masses pushed outward from their centers, especially southward, until a point was reached where the ice melted as rapidly as it advanced. There were at least six of these great advances, each one followed by a long interval of time.

In advancing from the distant northern centers of accumulation, the ice gathered up and transported all sorts and sizes of rock material. The character of this transported material varied with the character of the rocks over which the ice sheet advanced. During the advance a large amount of fine material,

known as rock flour, was produced by the grinding action of the moving ice. This fine material was transported southward by the glacial streams and later blown over the land by the wind. It now constitutes the major part of the mineral portion of the soil.

Only one of the great glacial advances, the Illinoisan, covered the area which now constitutes Randolph county, but later glaciers which did not advance so far south were of perhaps equal importance in that they contributed a large amount of rock flour, which, when distributed over the land, is known as loess. This material occurs as a blanket covering the glacial drift over practically the entire upland area of Randolph county.

The thickness of the drift varies from about 5 feet in the vicinity of Red Bud to 80 feet or more in other portions of the county. The loess blanket also varies in thickness. In the northwest corner of the county it is so shallow as to affect the productivity of the soil unfavorably, while in a belt adjacent to the Mississippi river it extends far below the depth to which the roots of crop plants penetrate.

The Mississippi river has been an important factor in the development of the soils in the bottom land adjacent to it, and it is still an important factor in determining their management. A considerable portion of this bottom is subject to annual overflow and other portions are in danger of flooding during periods of very high water.

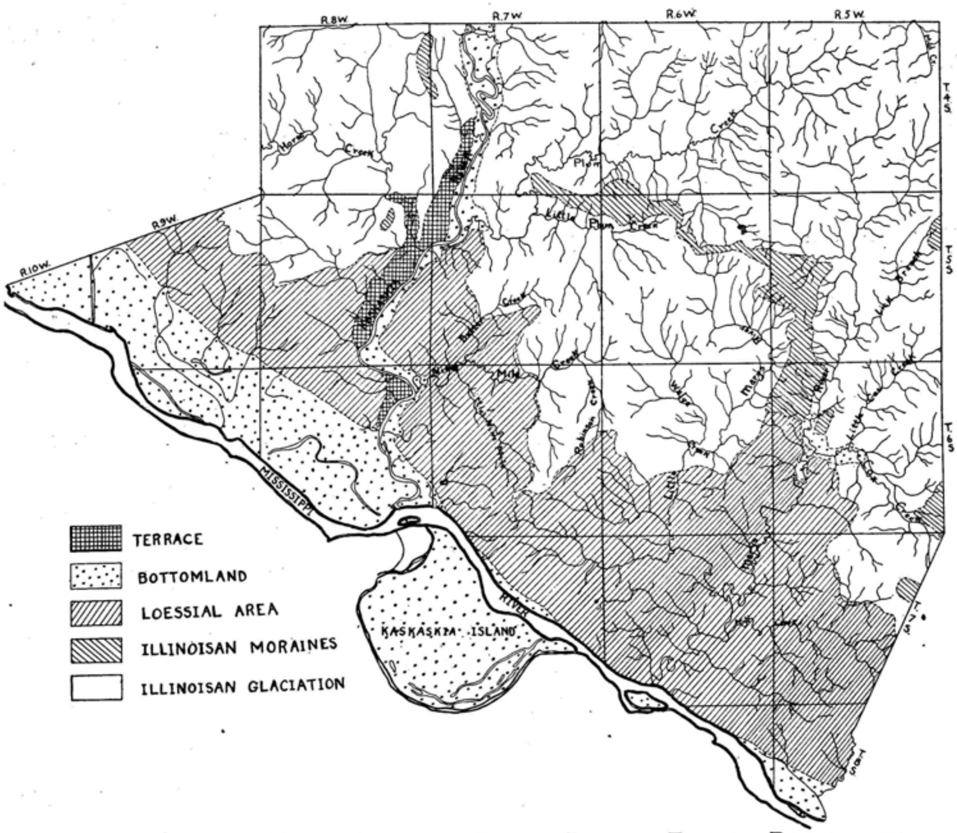

FIG. 1.—DRAINAGE MAP OF RANDOLPH COUNTY SHOWING TERRACE, BOTTOM-LAND, LOESSIAL, AND MORAINAL AREAS

PHYSIOGRAPHY AND DRAINAGE

The topography of Randolph county is very diversified. The central and northern portions of the county are flat to undulating, with narrow eroded slopes adjacent to the streams. A broken, hilly belt varying in width from two to ten miles extends in a northwest-southeast direction adjoining the Mississippi bottom. The southeastern portion of this belt is particularly hilly and broken.

The drainage of the county is almost entirely thru Mary's creek and Kaskaskia river and their tributaries, directly into the Mississippi river. The divide between these two drainage systems runs thru Coulterville, Sparta, Palestine, and thence to Fort Gage. The reader is referred to the accompanying drainage map, which shows the drainage systems of the county.

The following altitudes of a few places will give some idea of the general elevation of Randolph county: Coulterville, 542 feet; Baldwin, 465; Red Bud, 450; Evansville, 423; Sparta, 545; Chester, 384; Menard, 385; Prairie du Rocher, 397.

SOIL GROUPS

The soils of Randolph county are classified under the following groups:

(a) *Upland Prairie Soils,* including the upland soils that have not been covered with forests, at least not for any great length of time.

(b) *Upland Timber Soils,* including nearly all the upland areas that are now, or were formerly, covered with forests.

(c) *Terrace Soils,* including second bottom lands, formed by deposits from overloaded streams; and gravel or sand outwash plains formed by broad sheets of water arising from the melting of the glaciers.

(d, e) *Swamp and Bottom-Land Soils,* including the overflow lands or flood plains along streams, the swamps, and the poorly drained lowlands.

(f) *Residual Soils,* including rock outcrop areas, and soils formed in place thru weathering of rocks.

Table 1 gives a list of the soil types found in Randolph county, classified according to the groups described above. It also shows the area of each type in square miles and in acres, and its percentage of the total area of the county. The accompanying map, shown in three sections, gives the location and boundary of each soil type found in the county.

For explanations concerning the classification of soils and the interpretation of the map and tables, the reader is referred to the Appendix to this report.

TABLE 1.—SOIL TYPES OF RANDOLPH COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	(a) Upland Prairie Soils (300)			
330	Gray Silt Loam On Tight Clay	28.33	18 131	4.78
328	Brown-Gray Silt Loam On Tight Clay	12.78	8 179	2.15
		41.11	26 310	6.93
	(b) Upland Timber Soils (200, 300, 800)			
	Shallow Loess			
334	Yellow-Gray Silt Loam	168.02	107 533	28.33
335	Yellow Silt Loam	50.90	32 576	8.41
332	Light Gray Silt Loam On Tight Clay	3.54	2 266	.60
364	Yellow-Gray Sandy Loam	1.10	704	.19
365	Yellow Sandy Loam	.64	410	.11
	Deep Loess			
834	Yellow-Gray Silt Loam	42.68	27 315	7.18
835	Yellow Silt Loam	61.01	39 046	10.29
844	Yellow-Gray Fine Sandy Silt Loam	16.60	10 624	2.80
845	Yellow Fine Sandy Silt Loam	28.59	18 298	4.82
	Ridge Soils			
234	Yellow-Gray Silt Loam	9.08	5 811	1.54
235	Yellow Silt Loam	6.04	3 866	1.02
		388.20	238 449	65.29
	(c) Terrace Soils (1500)			
1544	Yellow-Gray Fine Sandy Silt Loam	.75	480	.13
1564	Yellow-Gray Sandy Loam	1.95	1 248	.33
1560.6	Light Brown Sandy Loam	.46	294	.08
1564.1	Yellow-Gray Sandy Loam On Clay	.86	550	.14
1534.1	Yellow-Gray Silt Loam On Clay	2.07	1 325	.35
1532	Light Gray Silt Loam On Tight Clay	4.14	2 650	.70
1516	Gray Clay	1.15	736	.19
1515	Drab Clay	.75	480	.13
		12.13	7 763	2.05
	(d, e) Swamp and Bottom-Land Soils (1300, 1400)			
1331	Deep Gray Silt Loam	24.44	15 642	4.29
1326	Brown Silt Loam	3.25	2 080	.55
1354, 1454	Mixed Loam	50.67	32 428	8.55
1379	Yellow-Brown Fine Sandy Loam	5.19	3 322	.87
1363	Mixed Sandy Loam	.44	281	.07
1315, 1415	Drab Clay	19.93	12 755	3.36
1426.1	Brown Silt Loam On Clay	10.12	6 477	1.70
1428.1	Brown Silt Loam On Tight Clay	1.33	851	.22
1426.2	Brown Silt Loam On Sand	5.92	3 789	1.00
1460	Brown Sandy Loam	8.56	5 478	1.44
1471	Brown Fine Sandy Loam	1.94	1 242	.33
1422.1	Brown-Gray Clay Loam On Tight Clay	1.55	992	.26
		133.34	85 337	22.64
	(f) Residual Soils (000)			
098	Stony Loam	.42	269	.07
099	Rock Outcrop, Limestone	.82	525	.14
099	Rock-Outcrop, Sandstone	1.08	691	.18
		2.32	1 485	.39
	Water	16.01	10 246	2.70
	Total	593.11	379 590	100.00

INVOICE OF THE ELEMENTS OF PLANT FOOD IN RANDOLPH COUNTY SOILS

In order to obtain a knowledge of its chemical composition, each soil type is sampled and subjected to chemical analysis for its important plant-food elements. For this purpose samples are taken usually in sets of three to represent different strata in the top 40 inches of soil; namely, an upper stratum (0 to 6⅔ inches), a middle stratum (6⅔ to 20 inches), and a lower stratum (20 to 40 inches). In the common kinds of soil the upper sampling stratum corresponds approximately to 2 million pounds of dry soil per acre, the middle sampling stratum to approximately twice this quantity, and the lower stratum to three times as much.

This, of course, is a purely arbitrary division of the soil section, which is very useful in arriving at a knowledge of the quantity and distribution of the elements of plant food in the soil; but it should be borne in mind that these strata seldom coincide with the natural strata as they actually exist in the soil and which are referred to as *surface, subsurface,* and *subsoil* in the descriptions of the soil types. By this system of sampling we have represented separately three zones for plant feeding. The upper, or surface layer, includes at least as much soil as is ordinarily turned with the plow, and this is the part with which the farm manure, limestone, and other fertilizing materials are incorporated.

The chemical analysis of a soil, obtained by the methods here employed, gives the invoice of the total stock of the several plant-food elements actually present in the soil strata sampled and analyzed. It should be understood, however, that the rate at which these elements are liberated from their insoluble forms—a matter of at least equal importance—is governed by many factors and is not necessarily proportional to the total amounts of the elements present in the soil.

For convenience in making application of the chemical analyses, the results as presented here have been translated from the percentage basis and are given in the accompanying tables in terms of pounds per acre. The assumption is made that for ordinary types of soil the three different strata weigh 2 million, 4 million, and 6 million pounds per acre, as already explained. While these values are only an approximation, it is believed that they will suffice for the purpose intended. It is a simple matter to convert these figures back to the percentage basis in case one desires to consider the information in that form.

Because of the extreme variations frequently found within a given soil type, no attempt is made to include in the tabulated results figures purporting to represent the amount of limestone or the degree of acidity. In examining each soil type in the field, however, numerous qualitative tests are made which furnish general information regarding the soil reaction; and in the discussion of the soil types which follow, recommendations based upon these tests are given concerning the lime requirement of the respective types. Such recommendations cannot be made specific in all cases because local variations exist, and because the lime requirement may change from time to time, especially under cropping and soil treatment. Therefore, in considering a particular field it often is desirable to determine its lime requirement, and in this connection the reader

is referred to the section in the Appendix dealing with the application of limestone (page 34).

THE UPPER SAMPLING STRATUM

In Table 2 are reported the amounts of organic carbon (which serves as a measure of the total organic matter), and the total quantities of nitrogen, phosphorus, sulfur, potassium, magnesium, and calcium in 2 million pounds of the surface soil of each type in Randolph county.

In connection with this table attention is called to the variation among the soil types with respect to their content of the different plant-food elements. It will be seen from the analyses that the variation in the organic-carbon content of the different soils is accompanied by a parallel variation in the nitrogen content; the organic-carbon content is usually from 10 to 12 times that of the total nitrogen. This close relationship is explained by the well-established facts that all organic matter of the soil contains nitrogen, and also that most of the soil nitrogen (usually 98 percent or more) is present in a state of organic combination. This close relationship is also maintained in the middle and lower sampling strata.

The organic matter and the accompanying nitrogen show considerable variation among the different soil types, tho they are comparatively low thruout the county. Of the thirty-one types of soil for which analyses are reported in this county, only five types contain more than 40,000 pounds of organic carbon in the surface stratum of an acre. These are Drab Clay (Terrace), Stony Loam (Residual), and three types in the swamp and bottom-land area, namely, Brown Silt Loam On Clay, Drab Clay, and Brown-Gray Clay Loam On Tight Clay. These types together occupy but 32.77 square miles or only 5.52 percent of the area of the county. The soils in the remainder of the county range in organic-carbon content from a minimum of 13,700 pounds an acre in Light Brown Sandy Loam, up to 38,240 pounds in the Brown Silt Loam, Bottom. The total nitrogen values are correspondingly low, being in these two types, 1,360 and 3,460 pounds, respectively. Because of the widespread deficiency of both nitrogen and organic matter in these soils, it is particularly important to grow legume crops frequently as green manures and plow them down, in addition to conserving and using all the animal manure which can be produced.

Other elements are not so closely associated with each other as are organic matter and nitrogen, tho there is some degree of correlation between sulfur, another element used by growing plants, and organic carbon. This is because a considerable tho varying proportion of the sulfur in the soil exists in the organic form, that is, as a constituent of the organic matter. The sulfur content of Randolph county soils is fairly low; it ranges in the surface soil from 420 pounds to 1,000 pounds an acre. This is partly accounted for by the low organic-matter content. Another factor is the atmospheric supply; sulfur dioxid escapes into the air in the gaseous products from the burning of all kinds of fuel, particularly coal. The gaseous oxid of sulfur is soluble in water and consequently is dissolved out of the air by rain and brought to the earth. In regions of large coal consumption, the amount of sulfur thus added to the soil is relatively large. At Urbana, during the eight-year period from 1917 to 1924, there was added

to the soil by the rainfall 3.5 pounds of sulfur an acre a month as an average. Similar observations have been made in localities in southwestern Illinois for shorter periods. At Sparta, Randolph county, in 1921, there was added in the rainfall 3.51 pounds of sulfur an acre in May, 7.78 pounds in August, and 9.96 pounds in September. At Ewing, Franklin county, during the entire season of 1921 the average monthly precipitation contained 2.27 pounds of sulfur an acre. These figures will afford some idea of the amount of sulfur added by rain and also of the wide variation in these amounts under different conditions. On the whole these facts would indicate that the sulfur added from the atmosphere sufficiently supplements that contained in the soil so that a need for sulfur fertilizers is not at all likely in Randolph county.

The potassium content of the soil ranges from 21,660 pounds an acre in Light Gray Silt Loam On Tight Clay to 40,220 pounds in Brown Silt Loam On Sand. From a quantitative point of view the least of these amounts is far above maximum crop requirements. However, the rate at which potassium is liberated in available condition from these large reserves varies widely, and the recommendations concerning potassium fertilizers in another part of this report are an indication that crop yields are limited on some soils by a deficiency of available potassium.

The phosphorus content of the upland and terrace soils of the county is low, while the bottom-land soils average nearly twice as much of this element. The smallest amount is found in Light Gray Silt Loam On Tight Clay, where it is but 440 pounds an acre. The largest amount, 2,300 pounds an acre, is in Brown Silt Loam On Clay, Bottom.

The amounts of soil calcium are, on the whole, rather low but no lower than is to be expected in soils which are acid. Soil acidity and calcium deficiencies are very frequently, but not always, associated. The smallest amount of calcium, 4,460 pounds an acre, is contained in Light Gray Silt Loam On Tight Clay. The largest amount in non-carbonate soils is 18,600 pounds in Brown Silt Loam On Clay, Bottom. Two soils containing calcium carbonate in the surface stratum—Brown Sandy Loam, Bottom, and Residual Stony Loam—contain 21,770 pounds and 51,180 pounds of calcium an acre respectively. Calcium is utilized by crops in fairly large amounts, so that in soils low in calcium content this element may not become available rapidly enough to supply crop needs. The liming of such soils, however, supplies any calcium deficiencies in addition to correcting acidity.

The soil content of magnesium in Randolph county averages about two-thirds as high as that of calcium, altho there are a few exceptional cases where it exceeds the calcium. The smallest amount found is 2,860 pounds an acre.

Considering the crop requirements for magnesium, it is doubtful whether magnesium ever becomes a limiting factor in crop production. This statement, however, does not imply a superiority of high calcium limestone over dolomitic or magnesian limestone. The usual commercial grades of high calcium and magnesian limestones are approximately equal in neutralizing value, and both types of stone also contain an abundance of calcium to make good any soil deficiencies in this element.

THE MIDDLE AND LOWER SAMPLING STRATA

In Tables 3 and 4 are recorded the amounts of the plant-food elements in the middle and lower sampling strata. In comparing these strata with the upper stratum or with each other, it is necessary to bear in mind that the data as given for the middle and lower sampling strata are on the basis of 4 million and 6 million pounds of soil, and should therefore be divided by two and three, respectively, before comparing them with each other or with the data for the upper stratum, which is on a basis of 2 million pounds.

With this in mind it will be noted, in comparing the three strata with each other, that all the soil types diminish rather rapidly in organic matter and nitrogen with increasing depth, and that this diminution is very marked even in the middle stratum. Ordinarily the percentages of the other elements except sulfur remain about the same or increase slightly in the lower strata; sulfur in nearly all cases decreases with increasing depth. There is a tendency for phosphorus to be low in the middle stratum; this is probably due to the removal of phosphorus by the roots of growing plants and its later incorporation with the surface soil in the accumulated plant residues.

It is frequently of interest to know the total supply of a plant-food element accessible to the growing crops. While it is impossible to obtain this information exactly, especially for the deeper-rooted crops, it seems probable that practically all the feeding range of the roots of most of our common field crops is included in the upper 40 inches of soil. By adding together, for a given soil type, the corresponding figures in Tables 2, 3, and 4, the total amounts of the respective plant-food elements to a depth of 40 inches may be ascertained.

Considered in this manner the tables reveal a rather wide variation in the abundance of the various elements in the different soil types, when measured by crop requirements. We may compare in this way two extreme soil types in the county—Drab Clay, Bottom, and Yellow-Gray Silt Loam, Upland. These are among the most extensive soil types in the county. They contain in the first 40 inches 15,370 and 5,610 pounds of nitrogen an acre, which is equivalent to the amount present in the same number of bushels of corn since a bushel of corn contains approximately a pound of nitrogen. Drab Clay thus contains nearly three times as much of this element as Yellow-Gray Silt Loam. Drab Clay also contains considerably more phosphorus and potassium than Yellow-Gray Silt Loam—8,720 pounds of phosphorus (equivalent to 51,400 bushels of corn), as compared with 5,070 pounds (equivalent to 29,900 bushels of corn). The total amounts of potassium in the two soil types are 237,900 and 180,610 pounds respectively (approximately equivalent to 1,252,000 and 950,000 bushels of corn).

These two soil types vary widely in calcium content, Drab Clay containing 95,080 pounds in the first 40 inches and Yellow-Gray Silt Loam, only 35,350 pounds. The amount of calcium in the soil is not of so great importance directly in connection with the corn crop as it is with respect to legumes. A ton of red clover hay, for example, contains approximately 29 pounds of calcium, and these two soils therefore contain respectively as much calcium as would be removed in 3,270 and 1,120 tons of red clover hay.

TABLE 2.—PLANT-FOOD ELEMENTS IN THE SOILS OF RANDOLPH COUNTY, ILLINOIS
UPPER SAMPLING STRATUM: ABOUT 0 TO 6⅔ INCHES
Average pounds per acre in 2 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	(a) Upland Prairie Soils (300)							
330	Gray Silt Loam On Tight Clay..	23 010	2 130	570	730	24 020	4 090	5 490
328	Brown-Gray Silt Loam On Tight Clay..........	32 980	2 680	720	540	26 340	4 480	79 200
	(b) Upland Timber Soils (200, 300, 800)							
	Shallow Loess							
334	Yellow-Gray Silt Loam.........	23 880	1 760	670	580	27 270	4 600	5 610
335	Yellow Silt Loam..............	23 820	1 760	760	420	32 460	8 860	9 080
332	Light Gray Silt Loam On Tight Clay..........	16 040	940	440	420	26 240	2 880	4 460
364	Yellow-Gray Sandy Loam......	22 180	2 080	820	540	33 900	4 320	8 420
365	Yellow Sandy Loam...........	22 180	2 080	820	540	33 900	4 320	8 420
	Deep Loess							
834	Yellow-Gray Silt Loam.........	16 970	1 750	750	490	34 460	4 400	6 450
835	Yellow Silt Loam..............	16 510	1 300	870	460	35 750	8 370	6 780
844	Yellow-Gray Fine Sandy Silt Loam	16 960	1 640	700	470	36 710	4 260	6 940
845	Yellow Fine Sandy Silt Loam....	15 910	1 710	1 570	470	36 450	10 430	10 160
	Ridge Soils							
234	Yellow-Gray Silt Loam.........	14 900	1 700	780	400	35 180	4 880	6 340
235	Yellow Silt Loam..............	15 520	1 340	760	440	39 940	7 560	5 380
	Terrace Soils (1500)							
1544	Yellow-Gray Fine Sandy Silt Loam	18 200	1 920	800	480	36 960	3 940	6 100
1564	Yellow-Gray Sandy Loam......	21 480	1 920	740	520	33 100	2 980	8 160
1560.6	Light Brown Sandy Loam......	13 700	1 360	620	520	28 980	2 860	7 820
1564.1	Yellow-Gray Sandy Loam On Clay..........	20 540	1 820	680	720	28 980	3 640	8 740
1534.1	Yellow-Gray Silt Loam On Clay	27 100	2 440	1 280	560	32 820	4 880	7 140
1532	Light Gray Silt Loam On Tight Clay..........	22 400	1 920	760	500	21 660	5 910	5 680
1516	Gray Clay....................	27 020	2 380	560	420	30 000	14 540	8 640
1515	Drab Clay....................	46 580	4 100	1 120	740	31 720	10 980	10 100
	Swamp and Bottom-Land Soils (1300, 1400)							
1331	Deep Gray Silt Loam..........	24 090	2 470	780	570	32 140	5 820	7 830
1326	Brown Silt Loam..............	38 240	3 460	1 660	740	37 900	10 900	10 380
1354, 1454	Mixed Loam[1].................	......	......	......	......	......	......	......
1379	Yellow-Brown Fine Sandy Loam	15 560	1 360	860	540	34 720	4 720	10 560
1363	Mixed Sandy Loam[1]...........	......	......	......	......	......	......	......
1315, 1415	Drab Clay....................	50 490	4 360	1 780	850	39 530	16 820	16 070
1426.1	Brown Silt Loam On Clay......	59 320	4 500	2 300	880	36 760	11 480	18 600
1428.1	Brown Silt Loam On Tight Clay	33 180	3 040	1 040	660	37 420	8 500	9 680
1426.2	Brown Silt Loam On Sand......	32 820	3 040	1 520	780	40 220	13 080	18 280
1460	Brown Sandy Loam............	17 920	1 630	1 190	720	33 320	9 390	21 770
1471	Brown Fine Sandy Loam.......	25 620	2 420	1 080	680	39 160	6 620	11 820
1422.1	Brown-Gray Clay Loam On Tight Clay................	49 460	3 900	1 340	700	33 320	10 360	12 000
	Residual Soils (000)							
098	Stony Loam..................	34 800	2 720	1 040	500	28 300	9 280	51 180
099	Rock Outcrop, Limestone, Sandstone......................	......	......	......	......	......	......	......

LIMESTONE AND SOIL ACIDITY.—In connection with these tabulated data it should be explained that the figures for limestone content and soil acidity are omitted not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in the form of general numerical averages reliable information concerning the limestone requirement for a given soil type. A general statement, however, will be found concerning the lime requirement of the respective soil types in connection with the discussions which follow.

[1]On account of the heterogeneous character of Mixed Loams, chemical analyses are not included for these types.

TABLE 3.—PLANT-FOOD ELEMENTS IN THE SOILS OF RANDOLPH COUNTY, ILLINOIS
MIDDLE SAMPLING STRATUM: ABOUT 6⅔ TO 20 INCHES
Average pounds per acre in 4 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (300)							
330	Gray Silt Loam On Tight Clay..	34 150	2 670	1 240	1 030	49 910	15 680	10 290
328	Brown-Gray Silt Loam On Tight Clay....................	44 920	3 120	1 480	760	59 360	15 280	16 200
	Upland Timber Soils (200, 300, 800)							
	Shallow Loess							
334	Yellow-Gray Silt Loam.........	20 090	1 950	1 340	740	59 030	16 850	9 620
335	Yellow Silt Loam..............	22 240	2 200	1 480	600	69 160	23 920	20 080
332	Light Gray Silt Loam On Tight Clay......................	16 200	1 040	720	600	54 240	10 520	9 160
364	Yellow-Gray Sandy Loam......	21 760	2 280	1 480	720	73 520	11 480	15 360
365	Yellow Sandy Loam............	21 760	2 280	1 480	720	73 520	11 480	15 360
	Deep Loess							
834	Yellow-Gray Silt Loam.........	19 610	2 370	1 820	770	75 940	14 890	12 490
835	Yellow Silt Loam..............	17 990	1 370	2 010	770	69 410	21 480	15 540
844	Yellow-Gray Fine Sandy Silt Loam.....................	19 860	2 260	2 200	740	78 700	16 260	15 140
845	Yellow Fine Sandy Silt Loam...	15 040	2 040	2 780	640	74 220	21 800	23 140
	Ridge Soils							
234	Yellow-Gray Silt Loam.........	19 990	2 400	1 720	520	74 280	18 480	12 320
235	Yellow Silt Loam..............	20 480	1 760	1 920	800	74 880	20 560	10 760
	Terrace Soils (1500)							
1544	Yellow-Gray Fine Sandy Silt Loam.....................	20 360	2 220	1 720	680	78 320	13 560	12 960
1564	Yellow-Gray Sandy Loam.......	15 320	1 440	1 040	600	66 840	7 770	15 680
1560.6	Light Brown Sandy Loam......	15 000	1 600	1 080	920	61 960	7 120	16 000
1564.1	Yellow-Gray Sandy Loam On Clay......................	18 520	2 000	880	1 080	61 960	12 120	16 640
1534.1	Yellow-Gray Silt Loam On Clay	18 480	2 120	1 960	880	69 440	12 320	12 560
1532	Light Gray Silt Loam On Tight Clay......................	21 840	2 400	1 040	840	47 400	14 800	14 760
1516	Gray Clay.....................	25 880	3 280	880	800	58 160	47 560	43 000
1515	Drab Clay.....................	58 400	5 160	1 600	960	63 600	23 320	18 160
	Swamp and Bottom-Land Soils (1300, 1400)							
1331	Deep Gray Silt Loam..........	31 260	3 680	1 380	920	64 400	9 880	14 480
1326	Brown Silt Loam..............	52 200	5 000	2 640	1 080	74 440	19 960	21 280
1354 1454	Mixed Loam[1]................	......	......	......	......	......	......	......
1379	Yellow-Brown Fine Sandy Loam	32 360	2 880	1 920	880	65 880	10 760	22 880
1363	Mixed Sandy Loam[1]..........	......	......	......	......	......	......	......
1315 1415	Drab Clay....................	55 950	5 770	2 960	1 030	78 190	36 520	30 550
1426.1	Brown Silt Loam On Clay......	96 360	7 160	3 200	1 520	75 760	24 800	36 200
1428.1	Brown Silt Loam On Tight Clay	40 280	4 160	1 440	920	73 280	23 080	20 360
1426.2	Brown Silt Loam On Sand......	43 560	4 680	2 640	1 440	78 400	25 920	36 960
1460	Brown Sandy Loam............	22 140	1 860	2 180	1 280	65 540	22 120	54 720
1471	Brown Fine Sandy Loam.......	47 360	3 920	2 160	1 080	79 680	18 720	25 320
1422.1	Brown-Gray Clay Loam On Tight Clay..................	58 440	4 520	1 760	1 200	68 440	30 240	23 320
	Residual Soils (000)							
098	Stony Loam[2].................	......	......	......	......	......	......	......
099	Rock Outcrop, Limestone, Sandstone....................	......	......	......	......	......	......	......

LIMESTONE AND SOIL ACIDITY.—See note in Table 2.

[1]On account of the heterogeneous character of Mixed Loams, chemical analyses are not included for these types.
[2]No samples could be taken of this type because of the stony condition.

TABLE 4.—PLANT-FOOD ELEMENTS IN THE SOILS OF RANDOLPH COUNTY, ILLINOIS
LOWER SAMPLING STRATUM: ABOUT 20 TO 40 INCHES
Average pounds per acre in 6 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (300)							
330	Gray Silt Loam On Tight Clay..	29 300	2 860	2 960	1 180	88 900	40 120	27 460
328	Brown-Gray Silt Loam On Tight Clay........................	30 600	1 920	3 660	840	93 420	37 560	34 320
	Upland Timber Soils (200, 300, 800)							
	Shallow Loess							
334	Yellow-Gray Silt Loam.........	21 050	1 900	3 060	920	94 310	37 410	20 120
335	Yellow Silt Loam..............	20 460	2 640	1 980	1 020	101 880	34 800	33 600
332	Light Gray Silt Loam On Tight Clay.........................	27 120	2 040	2 940	1 140	89 280	35 820	19 680
364	Yellow-Gray Sandy Loam......	24 780	2 280	3 840	960	110 940	35 340	22 500
365	Yellow Sandy Loam...........	24 780	2 280	3 840	960	110 940	35 340	22 500
	Deep Loess							
834	Yellow-Gray Silt Loam.........	21 540	2 940	3 680	1 020	108 150	33 650	18 750
835	Yellow Silt Loam..............	20 540	2 070	2 840	1 010	111 870	32 480	30 260
844	Yellow-Gray Fine Sandy Silt Loam......................	22 200	2 610	4 050	1 140	112 500	33 360	24 330
845	Yellow Fine Sandy Silt Loam...	18 490	2 010	3 540	720	114 810	34 050	47 400
	Ridge Soils							
234	Yellow-Gray Silt Loam.........	26 280	3 360	3 060	840	104 580	36 960	19 860
235	Yellow Silt Loam..............	19 320	1 920	2 040	900	102 120	27 360	19 200
	Terrace Soils (1500)							
1544	Yellow-Gray Fine Sandy Silt Loam......................	19 140	2 420	3 780	900	124 320	33 180	19 680
1564	Yellow-Gray Sandy Loam......	16 200	1 860	2 940	900	98 100	21 180	26 280
1560.6	Light Brown Sandy Loam......	19 260	2 160	2 100	1 500	89 340	16 200	25 800
1564.1	Yellow-Gray Sandy Loam On Clay.......................	22 560	2 940	2 160	1 200	97 860	36 960	26 580
1534.1	Yellow-Gray Silt Loam On Clay	16 620	2 880	3 360	780	95 220	40 380	17 340
1532	Light Gray Silt Loam On Tight Clay.......................	31 980	3 360	1 920	840	68 640	43 920	27 420
1516	Gray Clay..................	25 980	3 540	2 400	1 980	95 100	100 620	179 700
1515	Drab Clay	36 720	4 500	1 500	960	95 940	47 640	27 780
	Swamp and Bottom-Land Soils (1300, 1400)							
1331	Deep Gray Silt Loam..........	24 900	3 720	1 830	1 260	93 210	14 340	17 490
1326	Brown Silt Loam.............	70 980	7 320	4 080	1 620	111 840	31 380	33 000
1354 1454	Mixed Loam[1]...............	......	......	......	......	......	......	......
1379	Yellow-Brown Fine Sandy Loam	50 160	4 680	2 700	1 260	94 740	18 660	32 880
1363	Mixed Sandy Loam[1]..........	......	......	......	......	......	......	......
1315 1415	Drab Clay..................	47 200	5 240	3 980	1 380	120 180	55 860	48 460
1426.1	Brown Silt Loam On Clay......	89 580	7 800	3 420	1 500	119 220	59 040	44 640
1428.1	Brown Silt Loam On Tight Clay	38 400	4 080	2 520	1 140	96 660	38 580	29 340
1426.2	Brown Silt Loam On Sand......	29 160	3 660	3 420	1 260	117 180	27 540	57 900
1460	Brown Sandy Loam............	24 150	2 160	3 300	1 200	102 540	35 940	93 150
1471	Brown Fine Sandy Loam.......	39 540	4 140	3 480	1 440	114 480	38 520	36 420
1422.1	Brown-Gray Clay Loam On Tight Clay..................	64 200	5 100	2 160	1 140	88 500	60 480	37 080
	Residual Soils (000)							
098	Stony Loam[2].................	......	......	......	......	......	......	......
099	Rock Outcrop, Limestone, Sandstone.......................	......	......	......	......	......	......	......

LIMESTONE AND SOIL ACIDITY.—See note in Table 2.

[1]On account of the heterogeneous character of Mixed Loams, chemical analyses are not included for these types. [2]The stony condition of the subsoil precluded the taking of samples.

It is not intended to imply by the above statements that it is possible to predict how long it might be before a certain soil would become exhausted under a given system of cropping. Neither do the figures necessarily indicate the immediate procedure to be followed in the improvement of a soil, for factors other than the amount of plant-food elements present in the soil enter into consideration. Much depends upon the nature of the crops to be grown as to their ability to utilize plant-food materials, and much depends upon the condition of the plant-food substances themselves as to their availability. Finally, in planning the detailed procedure for the improvement of a soil, there enter for consideration all the economic factors involved in any fertilizer treatment. Such figures do, however, furnish an inventory of the total stocks of the plant-food elements that can possibly be drawn upon, and in this way contribute information that is fundamental if we are to plan intelligently, and in a broad way, systems of soil management that will conserve and improve the fertility of the land.

DESCRIPTION OF SOIL TYPES

(a) UPLAND PRAIRIE SOILS

The upland prairie soils of Randolph county cover only 41.11 square miles, or a little less than 7 percent of the area of the county. The two soils included in this group have a "tight clay" subsoil which interferes seriously with underdrainage. Both types occupy flat areas.

Gray Silt Loam On Tight Clay (330)

Gray Silt Loam On Tight Clay covers somewhat over two-thirds of the prairie area of the county. The type is very uniform except that the areas which are near the broken, hilly belt adjacent to Mississippi river contain more fine sand than those areas that lie north and northeast of Sparta.

The surface soil varies from 7 to 8 inches in depth and is a gray or light brownish gray silt loam. The subsurface, which is a gray silt loam or a gray fine sandy silt loam, extends to a depth of 15 to 18 inches. The subsoil is made up of two strata, the upper, a strongly mottled yellow or dark reddish brown plastic clay, the lower, a friable, strongly mottled yellow silt loam.

Management.—The acidity of this type, according to the tests made, varies from slight to strong in the surface and subsurface. The subsoil ordinarily shows no acidity, altho carbonates are not present. The great variation in the lime requirement of this type makes it advisable to test each field which is to be limed, as directed in the Appendix, page 34, or better, with the assistance of the county farm adviser or of the Experiment Station. The chief difficulty in the management of this type is poor drainage. The impervious subsoil makes it necessary to depend on surface drainage, and this method of removing surplus water is not entirely satisfactory. The amounts of organic matter and nitrogen in the soil are low, and special effort should be made to increase these constituents by growing legumes, preferably sweet clover.

The problem of phosphate fertilization has not been finally worked out for this soil type. The evidence thus far secured from the experiment fields in southern Illinois is in agreement in showing that the use of rock phosphate at

the rate of one ton an acre for a rotation does not result in sufficient increase in crop yields to pay for the phosphate. Altho, by the rock-phosphate treatment, the wheat yield was increased 4.5 bushels in the manure system and 4.0 bushels in the residue system, as an average of 30 crops on four fields, these increases are not large enough (in the absence of any consistent increases in the yields of the other crops in the rotation) to pay for the cost of the rock phosphate. Steamed bone meal has been used at the rate of 200 pounds an acre a year on three experiment fields in southern Illinois which are located on this soil type. This treatment has resulted in a fair profit on the DuBois field, but in a consistent loss on the Cutler and Odin fields. One series of plots on the Odin field has been used for a study of the comparative effect of steamed bone meal, acid phosphate, rock phosphate, and slag phosphate on crop yields, in a rotation of corn, oats, and three years of clover and timothy hay. These materials are applied at the rate of 200, 333, 666, and 260 pounds an acre a year respectively. In these experiments the increase in yield has in no case been large enough to pay for the cost of the phosphate.

The results, thus briefly stated, following the use of the various phosphates should not be interpreted to mean that none of the above phosphates can be used at a profit on this soil, but rather that none of them can be used at a profit *as they were used in these experiments.* The character of this soil, together with the well-known response of wheat to phosphates, suggests that further trials be made of phosphatic fertilizers, altho with the present information no definite recommendation as to the particular form of phosphorus carrier to use can be given. If either acid phosphate or basic slag is used, it should be applied at the rate of about 300 pounds an acre after plowing and before working down the seed bed. Rock phosphate should be applied in larger amounts, probably about 1,000 pounds an acre. It should be applied either in preparation for a clover crop, or turned down with some form of organic matter as explained in the Appendix, page 37.

The marked response exhibited by corn to potassium fertilization on this soil prompts the further suggestion that trials of potash be made, at least on an experimental scale, the material being applied direct to the corn crop. For this purpose a dressing of either potassium sulfate or potassium chlorid at the rate of 100 pounds an acre may be given the land in preparation for corn.

These suggestions presuppose that sufficient nitrogen is supplied for good crop yields thru the growing of legumes and the use of manure and crop residues. It should be noted that the experiment field results at Odin and at DuBois, which are included in the Supplement, pages 50 and 55, show a very substantial and profitable increase in yields on this soil following the use of limestone and some form of organic matter, either farm manure, green manures, or crop residues. The reader is referred to the Supplement of this report for results secured on certain of the experiment fields in the southern part of the state which are located on this soil type.

Brown-Gray Silt Loam On Tight Clay (328)

Brown-Gray Silt Loam On Tight Clay covers only 12.78 square miles, or 2.15 percent of the area of the county. It occurs, for the most part, in the vicinity of the village of Baldwin.

The surface is about 8 inches deep and is a grayish brown silt loam. The subsurface is a light gray silt loam and usually extends to a depth of about 20 inches. Occasionally this gray layer is found to consist of two strata, the upper being a brownish gray silt loam which passes into the true gray layer at a depth of about 13 inches. The subsoil is made up of two strata: the upper, to a depth of 32 to 36 inches, is a plastic, strongly mottled yellow or dark reddish brown clay; the lower is a friable, mottled yellow silt loam or silty clay loam frequently containing numerous dark red spots or blotches of iron oxid.

Management.—Tests show this type to be of medium acidity to the depth of the lower subsoil stratum, except in the case of the scald spots, which commonly contain lime concretions at a depth of 20 to 30 inches. Below the subsoil it is either not acid or only slightly so. No carbonates were found to a depth of 5 feet, except as above noted. Limestone should be applied at the rate of 2 or 3 tons an acre. It is advisable to test each field which is to be limed, as directed on page 34 of the Appendix, or better, with the assistance of the county farm adviser or of the Experiment Station, in order to determine the amount of limestone needed. The flat topography of the type, together with its impervious upper subsoil stratum, makes drainage the most serious difficulty in its management. Surface drainage must be depended upon for the removal of excess water since the impervious nature of the subsoil or "tight clay" makes the downward movement of water very slow. The amounts of nitrogen and organic-matter in the type are low, and these deficiencies should be met by growing legumes, preferably sweet clover, and using them for soil improvement either directly as green manures or indirectly as stable manure. The roots of sweet clover penetrate the "tight clay," and thus make use of the nutrient elements contained in it. Whether their penetration and subsequent decay will result in gradually opening up this relatively impervious stratum is not yet established.

There is not enough experimental evidence regarding the fertilization of this soil type to warrant a definite statement. Nitrogen is probably the limiting factor, and until this deficiency is met by the use of clovers, as advised above, the application of mineral fertilizers could not be expected to cause satisfactory increases in yield. The evidence thus far secured from the experiment fields indicates that rock phosphate cannot be used at a profit when applied at the rate of a ton an acre every four or five years; there is, of course the possibility that a lower rate of application might prove profitable. The possibility also suggests itself that the use of one of the more soluble phosphates, either acid phosphate or basic slag, for wheat might prove profitable. For a more complete discussion of the phosphate problem and advice as to how to apply the more soluble phosphates, the reader is referred to the recommendations for the management of Gray Silt Loam On Tight Clay (330), page 13. A suggestion will also be found on this same page regarding the trial of a potash fertilizer for corn. Results of experiments on the Alhambra and the Pana fields, representing Brown-Gray Silt Loam On Tight Clay, are reported in the Supplement, pages 57 and 58.

(b) UPLAND TIMBER SOILS

Yellow-Gray Silt Loam, Shallow Loess (334)

Yellow-Gray Silt Loam, Shallow Loess, is the most extensive soil type in Randolph county. It covers an area of 168.02 square miles, or about 28 percent of the area of the county. The type varies in topography from flat to gently rolling. The flat portions of the type have a compact subsoil which approaches the prairie subsoil in tightness; the undulating and rolling portions of the type have a subsoil which, tho frequently compact, is not impervious. The tendency towards tightness or imperviousness is characteristic of the more level areas of Yellow-Gray Silt Loam in southern Illinois. Another characteristic of the type as a whole in the southern part of the state is the presence of so-called scald spots.

The surface soil of this type varies in depth from 7 to 8 inches, in color from a light brownish gray to a yellowish gray, and in texture from a silt loam to a fine sandy silt loam. The subsurface varies from 14 to 20 inches in depth and is usually a light gray silt loam on the flat areas and a yellowish gray silt loam on the undulating areas. The subsoil appears to be made up of two strata. The upper is a mottled yellow, impervious clay on the flat areas and a mottled yellow, compact but not impervious, clay loam or silty clay loam on the undulating areas. The depth of this stratum varies from 30 to 38 inches. The lower subsoil stratum is a mottled yellow or reddish yellow, friable silty clay loam.

Management.—This type varies from medium to strongly acid. No carbonates occur to a depth of five feet, tho the reaction is usually neutral or only slightly acid below a depth of 40 inches. Careful tests should be made of each field before liming, as directed in the Appendix, page 34, or better, with the assistance of the county farm adviser or of the Experiment Station. Surface drainage is good except on the flat areas and, unfortunately, the tendency to "tightness" of the subsoil on these flat areas make surface drainage by means of furrows necessary. The organic-matter and nitrogen contents of the soil are low. The results of field experiments in southern Illinois are in agreement in showing that the use of limestone and clover or farm manure is very profitable on this soil type. The results from these same fields are likewise in agreement that rock phosphate cannot be used at a profit at the rate at which it has been applied on these fields; that is, at the rate of one ton an acre once in the rotation. No experimental information is available as to whether it can be used in smaller amounts at a profit; however, this is a possibility which is well worth trying in an experimental way. It is also suggested that one of the more soluble phosphates, either acid phosphate or basic slag, be tried as suggested for Gray Silt Loam On Tight Clay (see page 13). It would also be well to try potash for corn, as suggested in this same discussion.

Yellow Silt Loam, Shallow Loess (335)

Yellow Silt Loam, Shallow Loess, occupies 50.9 square miles, or 8.41 percent of the area of the county. It is of low agricultural value because of its steep topography, and is, for the most part, suited only to pasture and timber.

The character of this type varies greatly owing to differences in rate of erosion caused chiefly by differences in slope. The surface soil is usually a yellow

or grayish yellow silt loam. It may be a yellow or grayish yellow clay loam, depending on the amount of recent erosion. The subsurface and subsoil are similar to the surface in color but are heavier and are compact.

Management.—Leaching has removed the carbonates from this type to a depth greater than that to which roots can penetrate. This fact may explain why bluegrass does not do well over much of the area. The steep slopes make the land subject to serious washing. If limestone can be secured, both of the above difficulties can be met, but much of this land is too far from a shipping point to permit the purchase of limestone, and much of it is too steep for the profitable application of this material. Under such conditions it would seem that the land should be used for timber production. In case limestone can be considered, the reader is referred to the discussion of the Vienna experiment field in the Supplement, page 61.

Light Gray Silt Loam On Tight Clay, Shallow Loess (332)

Light Gray Silt Loam On Tight Clay, Shallow Loess, occurs in small flat areas thruout Yellow-Gray Silt Loam (334). It is the poorest type of upland soil in the county, but fortunately there is a total of only 3.54 square miles of it.

The surface is a gray silt loam or fine sandy silt loam and is about 6 inches deep. The subsurface is usually light gray to nearly white silt loam and passes very abruptly into the subsoil at a depth of about 20 inches. The subsoil comprizes two strata. The upper stratum is a very plastic, strongly mottled yellow or gray clay; the lower, starting at about 34 inches, is a friable, gray or strongly mottled silt loam.

Management.—The impervious subsoil of this type makes underdrainage impossible. The soil is strongly acid and very low in organic matter. Sweet clover will do well after about 4 tons of limestone an acre has been applied. Timothy and redtop are probably the surest crops on this land. See page 44 of the Supplement for an account of field experiments on this type of soil.

Yellow-Gray Sandy Loam, Shallow Loess (364)

Yellow-Gray Sandy Loam, Shallow Loess, occurs as long, narrow strips adjacent to the bottom land or terrace of Kaskaskia river. Only 1.1 square miles of the type are found in the county.

The surface is a light brown or yellowish brown fine sandy loam. The subsurface, beginning at about 7 inches, is a yellowish gray fine sandy loam, and the subsoil, beginning at about 16 inches, is a dark reddish yellow, silty clay loam. At a depth of about 37 inches, the subsoil becomes fairly friable and mottling appears. There is, however, no very distinct difference between these two subsoil strata.

Management.—Limestone should be applied at the rate of 2 to 3 tons an acre and clovers grown to provide nitrogen and to help increase the organic-matter content of the soil. The trial of one of the soluble phosphates, either acid phosphate or basic slag, for wheat, and a potash salt for corn is suggested. The method and rate of application of these fertilizing materials is explained in the discussion of the management of Gray Silt Loam On Tight Clay, page 13.

Yellow Sandy Loam, Shallow Loess (365)

Yellow Sandy Loam is of little importance because of its small area (.64 square mile) and its low agricultural value. The surface is a yellow sandy loam unless very recent erosion has exposed the deeper strata. The subsurface and subsoil are similar to the surface except that they are compact.

Management.—The reader is referred to the discussion of the management of Yellow Silt Loam (335), page 16, for suggestions regarding the management of this type.

Yellow-Gray Silt Loam, Deep Loess (834)

Yellow-Gray Silt Loam, Deep Loess, occurs on the narrow divides in the rough, hilly belt adjacent to the Mississippi river. It usually contains a higher percentage of fine sand than those areas of timber soil which are farther from the river. The profile of this type is similar to that of the rolling portions of Yellow-Gray Silt Loam, Shallow Loess (334).

The surface soil, which is 7 to 9 inches in depth, is a yellowish brown, fine sandy silt loam or silt loam. The subsurface to a depth of 18 or 20 inches is a slightly mottled, yellowish gray, fine sandy silt loam. The subsoil to a depth of about 32 inches is a mottled, yellow, silty clay loam, with a very decided compactness on the more level portions of the area which are adjacent to the line separating the shallow from the deep loess. Below 32 inches, the subsoil is a friable, mottled yellow silt loam.

Management.—The management requirements of this type are the same as those for Yellow-Gray Silt Loam, Shallow Loess, (see page 16), with the exception that less limestone is probably required, particularly near the bluff line.

Yellow Silt Loam, Deep Loess (835)

Yellow Silt Loam, Deep Loess, is similar to the corresponding shallow loess type with the following exceptions: it contains a higher percentage of fine sand, the slopes are longer and frequently steeper, and less limestone is probably required to grow clover. The tests made did not show carbonates to be present in the 5-foot section, and the absence of sweet clover growing wild in cuts indicates deep leaching of the carbonates; however, a lower degree of acidity was indicated by the acidity tests than was found to prevail in the shallow loess area. This type covers an area of about 61 square miles, or a little more than 10 percent of the area of the county.

Management.—Yellow Silt Loam, Deep Loess, should be used for orchards, pasture, or timber. The slopes are too long and too steep, as a rule, to permit the raising of cultivated crops. Clover can rarely be grown with any degree of success without limestone, and the roads are such as to prohibit its application if it has to be hauled from a shipping point. The problem may be solved by local crushing or home burning where a limestone outcrop is available.

Yellow-Gray Fine Sandy Silt Loam, Deep Loess (844)

Yellow-Gray Fine Sandy Silt Loam, Deep Loess, (844) is very similar to Yellow-Gray Silt Loam (834); in fact, the line separating the two is very in-

definite. The former type contains a higher percentage of fine sand than the major portion of the latter type; however, the proportion of fine sand decreases gradually from the river inland. The type occupies an area of 16.6 square miles, or 2.8 percent of the area of the county.

The surface soil is about 8 inches deep and is a grayish yellow fine sandy loam. The subsurface, extending to a depth of about 19 inches, is a pale yellow fine sandy loam. The subsoil is made up of two distinguishable strata; the upper to a depth of about 45 inches is a compact, slightly mottled, yellow silty clay loam; the lower is very similar in color and physical composition but is much less compact.

Management.—Since this type occurs on the crests of the narrow divides, the fields are narrow and irregular in outline. The soil is acid, tho not strongly so. The carbonates have been leached out to a depth of at least 5 feet. The fact that sweet clover is rarely found growing wild in the cuts indicates an advanced stage of leaching. The most important consideration in the management of this soil is to increase its nitrogen and organic-matter contents by the use of clover. It is necessary to make a moderate application of limestone in order to grow clover. The exact amount needed varies in different portions of the area, but in general, 2 tons an acre, if finely ground, will be sufficient to get a good stand of clover. It is not probable that this type will respond to rock phosphate very satisfactorily. The Unionville experiment field is located on soil that is similar, and the returns on that field are not such as to encourage the use of this material. The information which is now available indicates that if this land is to be used for growing the general farm crops, nitrogen and organic matter should be provided as advised above, and that in addition to this, one of the soluble phosphates, either acid phosphate or basic slag, should be tried for wheat, applying it after plowing and before working down the seed bed, at the rate of about 300 pounds an acre. It is also suggested that a trial be made of one of the potash salts, applying it at the rate of about 100 pounds an acre for corn, after plowing.

Yellow Fine Sandy Silt Loam, Deep Loess (845)

Yellow Fine Sandy Silt Loam is similar to Yellow Silt Loam (835) in topography; in character of soil, except that it contains a larger proportion of fine sand; in agricultural value; in degree of acidity; and in lack of carbonates to a depth of 5 feet.

Management.—The reader is referred to the discussion of the management of Yellow Silt Loam (835), page 18, for suggestions regarding the management of this type.

Yellow-Gray Silt Loam, Ridge (234)

Yellow-Gray Silt Loam, Ridge, occupies a very distinct morainal ridge which extends northward from the vicinity of Steeleville to about a mile from Sparta and takes a westerly direction to Plum creek. The slopes are strongly eroded owing more to lack of care in protecting them against washing than to their steepness.

The surface soil is a grayish yellow silt loam and is about 7 inches deep. The subsurface is a gray silt loam, and the subsoil, starting at about 20 inches, is a compact, mottled, yellow clay loam to a depth of about 35 inches, where it becomes friable.

Management.—This type requires practically the same management as Yellow-Gray Silt Loam (334), page 16, and in addition special precautions should be taken to control washing.

Yellow Silt Loam, Ridge (235)

Yellow Silt Loam, Ridge, was separated in the mapping from Yellow Silt Loam, Shallow Loess, on the basis of difference in formation. The two types are similar in character of soil, with the difference that the slopes of the ridge type are less steep, as a rule, than those of the shallow loess type; so far as is known, they require the same kind of management.

(c) TERRACE SOILS

Yellow-Gray Fine Sandy Silt Loam (1544)

Yellow-Gray Fine Sandy Silt Loam, Terrace, is limited almost entirely to small, disconnected areas bordering the lower course of Mary's creek. It is an unimportant type because of its small extent, .75 square mile. It occupies areas which are about 40 feet above the level of the adjacent bottom lands. These areas apparently are old formations. Some of them have a subsoil which has a tendency to be impervious, or "tight."

The surface soil, to a depth of about 7 inches, is a gray or yellowish gray, fine sandy silt loam. The subsurface varies from a mottled yellow silt loam to a gray silt loam, depending on whether a tight clay subsoil has been formed. A gray subsurface is associated with a tight subsoil. The subsoil, beginning at about 19 inches, when not tight is a compact, mottled, yellow clay loam, which becomes friable at about 35 inches. The same colors and depths are found on the tight areas, but the highly plastic, impervious nature of the tight layer has a marked influence on agricultural value.

Management.—The reader is referred to the discussion of the management of Yellow-Gray Fine Sandy Silt Loam (844), page 18, for suggestions regarding the management of this type. The requirements of the two types are probably the same, with the exceptions that a somewhat heavier application of limestone should be made to the terrace type and provision for surface drainage of the portions of the type having an impervious subsoil should be made.

Yellow-Gray Sandy Loam (1564)

Yellow-Gray Sandy Loam, Terrace, covers an area of about 2 square miles. It occurs, for the most part, adjacent to the bottom land of Kaskaskia river south of the village of Evansville. The areas west of the river are 20 feet or more above the level of the bottom land, while those east of the river are only a few feet above it.

This type differs from Yellow-Gray Sandy Loam, Upland (364), in its method of formation but is similar in other respects, including management requirements. For suggestions regarding the management of this type, the reader is referred to the discussion of the management of Yellow-Gray Sandy Loam, Upland, page 17.

Light Brown Sandy Loam (1560.6)

There is less than half a square mile of Light Brown Sandy Loam in Randolph county. This type occurs along the lower course of Kaskaskia river.

The surface is a light brown or grayish brown sandy loam. The subsurface, beginning at about 8 inches, is a grayish yellow sandy loam, and the subsoil is a mottled, yellow, compact, sandy clay loam.

Management.—This type has the same general management requirements as Yellow-Gray Sandy Loam, Upland, and the reader is referred to the management discussion found on page 17.

Yellow-Gray Sandy Loam On Clay (1564.1)

Yellow-Gray Sandy Loam On Clay occurs in small areas along the lower courses of Mary's creek and Kaskaskia river. Its total area is less than one square mile.

The surface, which is about 8 inches deep, is a brownish gray sandy loam. The subsurface is a gray sandy loam, and the subsoil, beginning at about 20 inches, is a plastic but pervious gray clay or clay loam.

Management.—Yellow-Gray Sandy Loam On Clay probably has the same management requirements as Yellow-Gray Sandy Loam (364), with the exception that its drainage is poorer. The reader is referred to the discussion on page 17 for suggestions regarding the management of this type.

Yellow-Gray Silt Loam On Clay (1534.1)

Yellow-Gray Silt Loam On Clay is found along Mary's, Butter, and Plum creeks, and Kaskaskia river, and has the same character of profile as the preceding type, Yellow-Gray Sandy Loam On Clay, with the exception that the surface and subsurface are silt loam. It occupies an area of little more than 2 square miles.

Management.—The reader is referred to the management paragraph for Yellow-Gray Silt Loam (334), page 16, for suggestions regarding the management of this type.

Light Gray Silt Loam On Tight Clay (1532)

Light Gray Silt Loam On Tight Clay, Terrace, occurs in small detached areas bordering nearly all the streams in the county. The total area of the type is only 4.14 square miles and this fact, together with its low agricultural value, makes it an unimportant type. It is similar in topography, character of profile, and management requirements to the corresponding upland type and differs from it only in origin.

Gray Clay (1516)

Gray Clay, Terrace, is found along the lower course of Kaskaskia river just south of Evansville. It occupies only 1.15 square miles and is of small importance. The surface soil is gray clay, plastic and difficult to work. There is no distinct stratification showing subsurface and subsoil development, but the color becomes a lighter gray and the degree of plasticity increases with increasing depth.

Management.—Gray Clay is not well suited to farming because its physical characteristics make it extremely difficult to work. Portions of the type are farmed. Post oak is the characteristic timber found on the type, and probably the entire area should be used for timber production.

Drab Clay (1515)

Drab Clay, Terrace, is found in small areas along the lower course of Kaskaskia river. Its total area in the county is less than one square mile.

This type is similar to Gray Clay (1516), described above. It differs from Gray Clay in that its color thruout the 40-inch section is drab instead of gray and it is slightly less plastic.

(d, e) SWAMP AND BOTTOM-LAND SOILS (1300, 1400)

It has been found advisable to abandon the classification of swamp and bottom-land soils into the two groups "Old" and "Late" as shown on the map (which was made in 1916-17), because this classification was based on the supposed age of the soil material and not on the stage of maturity of the soil. The difficulty which arises in attempting to adhere to this classification is well illustrated by the following example taken from Randolph county. Yellow-Brown Fine Sandy Loam (1379) is classified in the "Old" group. This type consists of a recent deposit from the adjacent bluffs and lies on top of surrounding types which are classified as "Young" or "Late." This deposit is so recent that none of the characteristics of mature soils have been developed. This brief discussion is intended to clear up the question which might arise as to the reason for not adhering in the type descriptions to the grouping of bottom-land types which appears on the soil map.

Deep Gray Silt Loam (1331)

Deep Gray Silt Loam, Bottom, comprizes the major portion of the small bottoms thruout the county. Its total area is 24.44 square miles.

The surface soil is about 7 inches deep and is a light brownish gray silt loam. Distinct subsurface and subsoil horizons are not usually found to have been developed. Over a considerable portion of the type a gray fine sandy silt loam subsurface is found extending to a depth of about 30 inches, and then a strongly mottled, chocolate-colored, fine sandy silt loam subsoil, which is not plastic and only slightly compact, occurs.

Management.—This type varies in acidity from slight to strong, tho but a small portion of it shows a high lime requirement because of frequent overflows which tend to keep the acidity neutralized. A large percentage of the type

is under cultivation. It is well adapted to corn growing but, because of flooding, the maintaining of the nitrogen and organic-matter supply is peculiarly difficult. Wherever clover can be grown, the lime requirement should be satisfied. On account of extreme difficulties in transportation in much of this district, the use of burned lime instead of limestone, as representing a more concentrated product, might be considered in some cases. Clover should then be grown systematically, for this soil is very low in nitrogen and organic matter.

Brown Silt Loam (1326)

Brown Silt Loam, Bottom, is found along Kaskaskia river, and covers a total area of only 3.25 square miles. It is a recent soil, as shown by the absence of horizon development. The surface to a depth of about 12 inches is brown silt loam. At this depth the color changes to drabbish brown with slight mottling.

Management.—This type is usually medium acid and requires 2 or 3 tons of limestone an acre to grow sweet clover. It is a fertile soil, well adapted to clover growing, but is subject to overflow, thus largely eliminating the possibility of growing clover as a means of maintaining the organic-matter and nitrogen supply. No fertilizer application is advised for this type, but it is suggested that every means available for maintaining the organic-matter content of the soil be utilized.

Mixed Loam (1354, 1454)

Mixed Loam is found in the bottoms along the upper courses of the small streams thruout the county and in the Mississippi bottom. It occupies a total area of 50.67 square miles. Much of this land is subject to frequent flooding and, while it is productive, it must be used for crops which can be planted and harvested between flood periods. Much of this type is occupied by timber. The timber growth consists of sycamore, maple, elm, hickory, oak, and other varieties. The areas classified as Mixed Loam consist of a variety of soils which cannot successfully be separated. Some of this land is under cultivation and much of it would be well adapted to general farming were it not for frequent flooding.

Yellow-Brown Fine Sandy Loam (1379)

Yellow-Brown Fine Sandy Loam, Bottom, occupies an area of 5.19 square miles. It consists of a deposit of wash derived from the adjacent bluffs and it varies considerably in depth. The underlying soil upon which it has been deposited is frequently encountered within the 40-inch section. The deposit is so recent that but slight horizon development has taken place.

The surface to a depth of 9 or 10 inches is yellowish brown fine sandy loam and below this, down to the underlying soil upon which the deposit has been made, it is grayish yellow in color and is of the same texture as the surface.

Management.—This soil shows no acidity and is productive and easily worked. It is an excellent alfalfa soil and is well adapted to general farming or to vegetable growing. No fertilizer treatment is advised for this type, but it is recommended that every means available for increasing its nitrogen and organic-matter supply be utilized.

Mixed Sandy Loam (1363)

Mixed Sandy Loam occupies less than half a square mile. It is similar to Mixed Loam except that its texture is coarser and, in general, is not so good a soil as Mixed Loam because of its coarse texture.

Drab Clay (1315, 1415)

There are almost 20 square miles of Drab Clay, Bottom, mapped in Randolph county, most of which is in the Mississippi bottom. This type has a dark, drab-colored surface soil to a depth of about 8 inches, and is drab-colored below 8 inches. The texture is clay thruout the soil section and dark reddish yellow splotches begin to occur at a depth of about 16 inches.

Management.—Much of the Drab Clay in subject to overflow and is poorly drained. It is farmed to some extent, tho a considerable portion of it is in timber. Its heavy nature and high plasticity makes it an undesirable soil for farming even tho it were drained. The chief requirement in the management of this type, after drainage, is fresh organic matter. It is but slightly acid, even where infrequently flooded, and the frequently flooded portions of the type show no acidity.

Brown Silt Loam On Clay (1426.1)

Brown Silt Loam On Clay, Bottom, has a total area of 10.12 square miles. It is a productive soil, tho inadequately drained.

The surface soil, which is usually about 9 inches deep, is brown silt loam, frequently a heavy phase. In some portions of the area the subsurface, 9 to 18 inches, is grayish brown silt loam, while in others this stratum is black clay which rests on drab clay at a depth of about 18 or 19 inches. In case the grayish brown stratum is present, it usually rests on a thin stratum of black clay and the drab clay occurs at a depth of about 26 inches instead of at 18 or 19 inches as in the former case.

Management.—There is need for better drainage over most of the area occupied by this type. The reaction varies from neutral to slightly acid. In no case would more than 2 tons of limestone an acre be needed for sweet clover or alfalfa. Provision should be made for adding organic matter at regular intervals. No soil treatment other than good tillage, fresh organic matter, and limestone where needed, is advised.

Brown Silt Loam On Tight Clay (1428.1)

Brown Silt Loam On Tight Clay occurs in small areas in the Mississippi bottom between Fort Gage and Prairie du Rocher. The total area of this type in Randolph county is about 1½ square miles.

The surface soil, which is about 7 inches deep, is brown silt loam. The subsurface is usually a thin stratum of only 3 or 4 inches in thickness. It is grayish brown silty clay loam. The upper subsoil which extends to a depth of about 28 or 30 inches is a mottled, brown and yellow clay loam, fairly compact and plastic. The lower subsoil is a very friable, mottled, yellow sandy silt loam.

Management.—This type is in need of better drainage. The presence of a rather impervious subsoil makes it necessary to depend entirely on open ditches for the removal of excess water. The surface and subsurface are not acid and the subsoil shows only slight or medium acidity. No treatment is advised for this soil other than improving the drainage and providing for the regular return of organic matter.

Brown Silt Loam On Sand (1426.2)

Brown Silt Loam On Sand occurs mainly on Kaskaskia Island. A total of 5.92 square miles was mapped. Its peculiar formation in long narrow strips between depressions of Drab Clay (1415) or Brown Sandy Loam (1460) is due to river action. The depth to sand varies from 5 or 6 inches to about 30 inches.

The surface soil is brown silt loam and is about 8 inches deep, where the sand does not occur within that distance below the surface. Below the surface soil down to the sand is a drabbish brown silt loam.

Management.—This soil, where not subject to too frequent overflow, is excellent alfalfa land and is equally good for any of the general farm crops. It is not acid and requires only good tillage and fresh supplies of organic matter to keep it in excellent condition.

Brown Sandy Loam (1460)

Brown Sandy Loam, Bottom, occurs, for the most part, as long narrow ridges of sand-bar like formation. A total of 8.56 square miles is found in the county, and all of it is located in the Mississippi bottom and on Kaskaskia Island. It varies from a good productive sandy loam to coarse sand. Much of it, however, is good soil, but the danger of frequent overflow lessens its agricultural value, particularly on the southern side of Kaskaskia Island and just west of the mouth of Kaskaskia river.

Management.—The higher portions are becoming acid and require about 2 tons of limestone an acre to grow sweet clover or alfalfa; otherwise no fertilizer treatment is advised. It is good alfalfa land unless subject to frequent overflow.

Brown Fine Sandy Loam (1471)

Brown Fine Sandy Loam, Bottom, is similar in origin to Yellow-Brown Fine Sandy Loam (1379) but is an older formation, as is shown by the development of fairly distinct strata or horizons. A total of less than 2 square miles of the type occurs in the county.

The surface soil is about 10 inches deep and is a brown sandy loam. The subsurface extends to a depth of about 20 inches and is a grayish brown fine sandy loam. The subsoil to the depth sampled (40 inches) is a brownish gray fine sandy silt loam.

Management.—This is an excellent soil. It is not acid in the surface and is only very slightly acid in the subsurface and subsoil.

Brown-Gray Clay Loam On Tight Clay (1422.1)

Brown-Gray Clay Loam On Tight Clay occurs in relatively small areas in the Mississippi bottom south of Modoc station. The total area of the type in the county is 1.55 square miles.

The surface soil is a brown clay and is about 8 inches deep. The subsurface in places is drab clay which extends without change to 40 inches or more in depth. In other places there is a grayish drab clay stratum to a depth of about 14 inches and then a highly plastic drab clay to 40 inches or more in depth.

Management.—This type is not essentially different in management requirements from Drab Clay (1415). It is a little easier to work, but it is in need of improved drainage to make it a desirable soil for general farming.

(f) RESIDUAL SOILS

The total area of the formations in Randolph county mapped as Residual Soils comprizes only 2.32 square miles. Nearly one-half of this total area is occupied by outcrops of sandstone which have no agricultural value. The limestone outcrops may in many cases be used as local sources of ground limestone or of burned lime, if conditions are such that home burning of the stone can be practiced. Miscellaneous samples examined indicate that much of this rock is of very good quality for such a purpose. The Stony Loam (098) which comprizes less than one-half square mile is of no value other than for pasture or timber.

APPENDIX

EXPLANATIONS FOR INTERPRETING THE SOIL SURVEY

CLASSIFICATION OF SOILS

In order intelligently to interpret the soil maps, the reader must understand something of the method of soil classification upon which the survey is based. Without going far into details the following paragraphs are intended to furnish a brief explanation of the general plan of classification used.

The type is the unit of classification and each type has definite characteristics. In establishing types, the following factors are taken into account: the character of the horizons composing the soil as to depth and thickness, physical composition, structure, organic-matter content, color, reaction, and carbonate content; the topography; the native vegetation; and the geological origin of the soil.[1]

Not infrequently areas are encountered in which type characters are not distinctly developed or in which they show considerable variation. When these variations are considered to have sufficient significance, type separations are made whenever the areas involved are sufficiently large. Because of the almost infiinite variability occurring in soils, one of the exacting tasks of the soil surveyor is to determine the degree of variation which is allowable for any given type.

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[1] Since some of the terms used in designating the factors which are taken into account in establishing soil types are technical in nature, the following explanations are introduced:

Horizon. A layer or stratum of soil which differs discernibly from those adjacent in color, texture, structure, chemical composition, or a combination of these characteristics, is called an horizon.

Depth and Thickness. The horizons or layers which make up the soil profile vary in depth and thickness. These variations are distinguishing features in the separation of soils into types.

Physical Composition. The physical composition, sometimes referred to as "texture," is a most important feature in characterizing a soil. The texture depends upon the relative proportions of the following physical constituents: clay, silt, fine sand, sand, gravel, stones, and organic material.

Structure. The term "structure" has reference to the aggregation of particles within the soil mass and carries such qualifying terms as open, granular, compact.

Organic-Matter Content. The organic matter of soil is derived largely from plant tissue and it exists in a more or less advanced stage of decomposition. Organic matter forms the predominating constituent in certain soils of swampy formation.

Color. Color is determined to a large extent by the proportion of organic matter, but at the same time it is modified by the mineral constituents, especially by iron compounds.

Reaction. The term "reaction" refers to the chemical state of the soil with respect to acid or alkaline condition. It also involves the idea of degree, as strongly acid or strongly alkaline.

Carbonate Content. The carbonate content has reference to the calcium carbonate (limestone) present, which in some cases may be associated with magnesium or other carbonates. The depth at which carbonates are found may become a very important factor in determining the soil type.

Topography. Topography has reference to the lay of the land, as level, rolling, hilly, etc.

Native Vegetation. The vegetation or plant growth before being disturbed by man, as prairie grasses and forest trees, is a feature frequently recognized in determining soil types.

Geological Origin. Geological origin involves the idea of character of rock materials composing the soil as well as the method of formation of the soil.

Classifying Soil Types.—In the system of classification used, the types fall first into four general groups based upon their geological relationships; namely, upland, terrace, swamp and bottom land, and residual. These groups may be subdivided into prairie soils and timber soils, altho as a matter of fact this subdivision is applied in the main only to the upland group. These terms are all explained in the foregoing part of the report in connection with the description of the particular soil types.

Naming and Numbering Soil Types.—In the Illinois soil survey a system of nomenclature is used which is intended to make the type name convey some idea of the nature of the soil. Thus the name "Yellow-Gray Silt Loam" carries in itself a more or less definite description of the type. It should not be assumed, however, that this system of nomenclature makes it possible to devise type names which are adequately descriptive, because the profile of mature soils is usually made up of four or more horizons and it is impossible to describe each horizon in the type name. The color and texture of the surface soil are usually included in the type name and when material such as sand, gravel, or rock lies at a depth of less than 30 inches, the fact is indicated by the word "on," and when its depth exceeds 30 inches, by the word "over"; for example, Brown Silt Loam On Gravel, and Brown Silt Loam Over Gravel.

As a further step in systematizing the listing of the soils of Illinois, recognition is given to the location of the types with respect to the geological areas in which they occur. According to a geological survey made many years ago, the state has been divided into seventeen areas with respect to geological formation and, for the purposes of the soil survey, each of these areas has been assigned an index number. The names of the areas together with their general location and their corresponding index numbers are given in the following list.

000 *Residual*, soils formed in place thru disintegration of rocks, and also rock outcrop
100 *Unglaciated*, comprizing three areas, the largest being in the south end of the state
200 *Illinoisan moraines*, including the moraines of the Illinoisan glaciations
300 *Lower Illinoisan glaciation*, covering nearly the south third of the state
400 *Middle Illinoisan glaciation*, covering about a dozen counties in the west-central part of the state
500 *Upper Illinoisan glaciation*, covering about fourteen counties northwest of the middle Illinoisan glaciation
600 *Pre-Iowan glaciation*, but now believed to be part of the upper Illinoisan
700 *Iowan glaciation*, lying in the central northern end of the state
800 *Deep loess areas*, including a zone a few miles wide along the Wabash, Illinois, and Mississippi rivers
900 *Early Wisconsin moraines*, including the moraines of the early Wisconsin glaciation
1000 *Late Wisconsin moraines*, including the moraines of the late Wisconsin glaciation
1100 *Early Wisconsin glaciation*, covering the greater part of the northeast quarter of the state
1200 *Late Wisconsin glaciation*, lying in the northeast corner of the state
1300 *Old river-bottom and swamp lands*, found in the older or Illinoisan glaciation
1400 *Late river-bottom and swamp lands*, those of the Wisconsin and Iowan glaciations
1500 *Terraces*, bench or second bottom lands, and gravel outwash plains
1600 *Lacustrine deposits*, formed by Lake Chicago, the enlarged glacial Lake Michigan

For further information regarding these geological areas the reader is referred to the general map published in Bulletin 123.

Another set of index numbers is assigned to the classes of soils as based upon physical composition. The following list contains the names of these classes with their corresponding index numbers.

Index Number Limits	Class Names
0 to 9	Peats
10 to 12	Peaty loams
13 to 14	Mucks
15 to 19	Clays
20 to 24	Clay loams
25 to 49	Silt loams
50 to 59	Loams
60 to 79	Sandy loams
80 to 89	Sands
90 to 94	Gravelly loams
95 to 97	Gravels
98	Stony loams
99	Rock outcrop

As a convenient means of designating types and their location with respect to the geological areas of the state, each type is given a number made up of a combination of the index numbers explained above. This number indicates the type and the geological area in which it occurs. The geological area is always indicated by the digits of the order of hundreds while the balance of the number designates the type. To illustrate: the number 1126 means Brown Silt Loam in the early Wisconsin glaciation, 434 means Yellow-Gray Silt Loam of the middle Illinoisan glaciation. These numbers are especially useful in designating very small areas on the map and as a check in reading the colors.

A complete list of the soil types occurring in each county, along with their corresponding type numbers and the area covered by each type, will be found in the respective county soil reports in connection with the maps.

SOIL SURVEY METHODS

Mapping of Soil Types.—In conducting the soil survey, the county constitutes the unit of working area. The field work is done by parties of two to four men each. The field season extends from early in April to Thanksgiving. During the winter months the men are engaged in preparing a copy of the soil map to be sent to the lithographer, a copy for the use of the county farm adviser until the printed map is available, and a third copy for use in the office in order to preserve the original official map in good condition.

An accurate base map for field use is necessary for soil mapping. These maps are prepared on a scale of one inch to the mile, the official data of the original or subsequent land survey being used as the basis in their construction. Each surveyor is provided with one of these base maps, which he carries with him in the field; and the soil type boundaries, together with the streams, roads, railroads, canals, town sites, and rock and gravel quarries are placed in their proper location upon the map while the mapper is on the area. With the rapid development of road improvement during the past few years, it is almost inevitable that some recently established roads will not appear on the published soil map. Similarly, changes in other artificial features will occasionally occur in the interim between the preparation of the map and its publication. The detail or minimum size of areas which are shown on the map varies somewhat, but in general a soil type if less than five acres in extent is not shown.

A soil auger is carried by each man with which he can examine the soil to a depth of 40 inches. An extension for making the auger 80 inches long is taken

by each party, so that the deeper subsoil may be studied. Each man carries a compass to aid in keeping directions. Distances along roads are measured by a speedometer or other measuring device, while distances in the field away from the roads are measured by pacing.

Sampling for Analysis.—After all the soil types of a county have been located and mapped, samples representative of the different types are collected for chemical analysis. The samples for this purpose are usually taken in three depths; namely, 0 to 6⅔ inches, 6⅔ to 20 inches, and 20 to 40 inches, as explained in connection with the discussion of the analytical data on page 6.

PRINCIPLES OF SOIL FERTILITY

Probably no agricultural fact is more generally known by farmers and landowners than that soils differ in productive power. A fact of equal importance, not so generally recognized, is that they also differ in other characteristics such as response to fertilizer treatment and to management.

The soil is a dynamic, ever-changing, exceedingly complex substance made up of organic and inorganic materials and teeming with life in the form of microorganisms. Because of these characteristics, the soil cannot be considered as a reservoir into which a given quantity of an element or elements of plant food can be poured with the assurance that it will respond with a given increase in crop yield. In a similar manner it cannot be expected to respond with perfect uniformity to a given set of management standards. To be productive a soil must be in such condition physically with respect to structure and moisture as to encourage root development; and in such condition chemically that injurious substances are not present in harmful amounts, that a sufficient supply of the elements of plant food become available or usable during the growing season, and that lime materials are present in sufficient abundance favorable for the growth of the higher plants and of the beneficial microorganisms. Good soil management under humid conditions involves the adoption of those tillage, cropping, and fertilizer treatment methods which will result in profitable and permanent crop production on the soil type concerned.

The following paragraphs are intended to state in a brief way some of the principles of soil management and treatment which are fundamental to profitable and continued productivity.

CROP REQUIREMENTS WITH RESPECT TO PLANT-FOOD MATERIALS

Ten different elements of plant food are essential for the growth and formation of every plant. These elements are: *carbon, oxygen, hydrogen, nitrogen, phosphorus, sulfur, potassium, magnesium, calcium, and iron.* Some seasons in central Illinois are sufficiently favorable to allow the production of at least 50 bushels of wheat per acre, 100 bushels of corn, 100 bushels of oats, and 4 tons of clover hay. When such crops, growing under favorable climatic and cultural conditions and uninjured by disease or insect pests, are not produced the failure is due to unfavorable soil conditions, which may result from poor drainage, poor physical condition, or from an actual deficiency in one or more of the elements of plant food.

TABLE 5.—PLANT-FOOD ELEMENTS IN COMMON FARM CROPS[1]

Produce		Nitrogen	Phosphorus	Sulfur	Potassium	Magnesium	Calcium	Iron
Kind	Amount							
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Wheat, grain	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat straw.	1 ton	10.00	1.60	2.80	18.00	1.60	3.80	.60
Corn, grain.	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn stover.	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs.	1 ton	4.00	. . . . .	. . . . .	4.00	. . . . .	. . . . .	. . . . .
Oats, grain.	1 bu.	.66	.11	.06	.16	.04	.02	.01
Oat straw.	1 ton	12.40	2.00	4.14	20.80	2.80	6.00	1.12
Clover seed.	1 bu.	1.75	.50	. . . . .	.75	.25	.13	. . . . .
Clover hay.	1 ton	40.00	5.00	3.28	30.00	7.75	29.25	1.00
Soybeans seed.	1 bu.	3.22	.39	.27	1.26	.15	.14	. . . . .
Soybean hay.	1 ton	43.40	4.74	5.18	35.48	13.84	27.56	. . . . .
Alfalfa hay.	1 ton	52.08	4.76	5.96	16.64	8.00	22.26	. . . . .

[1]These data are brought together from various sources. Some allowance must be made for the exactness of the figures because samples representing the same kind of crop or the same kind of material frequently exhibit considerable variation.

Table 5 shows the requirements of some of our most common field crops with respect to the seven plant-food elements furnished by the soil. The figures show the weight in pounds of the various elements contained in a bushel or in a ton, as the case may be. From these data the amount of any element removed from an acre of land by a crop of a given yield can easily be computed.

PLANT-FOOD SUPPLY

Of the ten elements of plant food, three (carbon, oxygen, and hydrogen) are secured from air and water, and seven from the soil. Nitrogen, one of these seven elements obtained from the soil by all plants, may also be secured from the air by the class of plants known as legumes, in case the amount liberated from the soil is insufficient; but even these plants, which include only the clovers, peas, beans, and vetches among our common agricultural plants, are dependent upon the soil for the other six elements (phosphorus, potassium, magnesium, calcium, iron, and sulfur), and they also utilize the soil nitrogen so far as it becomes soluble and available during their period of growth.

The vast difference with respect to the supply of these essential plant-food elements in different soils is well brought out in the data of the Illinois soil survey. For example, it has been found that the nitrogen in the surface 6⅔ inches, which represents the plowed stratum, varies in amount from 180 pounds per acre to more than 35,000 pounds. In like manner the phosphorus content varies from about 420 to 4,900 pounds, and the potassium ranges from 1,530 to about 58,000 pounds. Similar variations are found in all of the other essential plant-food elements of the soil.

With these facts in mind it is easy to understand how a deficiency of one of these elements of plant food may become a limiting factor of crop production. When an element becomes so reduced in quantity as to become a limiting factor

TABLE 6.—PLANT-FOOD ELEMENTS IN MANURE, ROUGH FEEDS, AND FERTILIZERS[1]

Material	Pounds of plant food per ton of material		
	Nitrogen	Phosphorus	Potassium
Fresh farm manure	10	2	8
Corn stover	16	2	17
Oat straw	12	2	21
Wheat straw	10	2	18
Clover hay	40	5	30
Cowpea hay	43	5	33
Alfalfa hay	50	4	24
Sweet clover (water-free basis)[2]	80	8	28
Dried blood	280	.....	.....
Sodium nitrate	310	.....	.....
Ammonium sulfate	400	.....	.....
Raw bone meal	80	180	.....
Steamed bone meal	20	250	.....
Raw rock phosphate	.....	250	.....
Acid phosphate	.....	125	.....
Potassium chlorid	.....	.....	850
Potassium sulfate	.....	.....	850
Kainit	.....	.....	200
Wood ashes[3] (unleached)	.....	10	100

[1]See footnote to Table 5.
[2]Young second year's growth ready to plow under as green manure.
[3]Wood ashes also contain about 1,000 pounds of lime (calcium carbonate) per ton.

of production, then we must look for some outside source of supply. Table 6 is presented for the purpose of furnishing information regarding the quantity of some of the more important plant-food elements contained in materials most commonly used as sources of supply.

LIBERATION OF PLANT FOOD

The chemical analysis of the soil gives the invoice of plant-food elements actually present in the soil strata sampled and analyzed, but the rate of liberation is governed by many factors, some of which may be controlled by the farmer, while others are largely beyond his control. Chief among the important controllable factors which influence the liberation of plant food are the choice of crops to be grown, the use of limestone, and the incorporation of organic matter. Tillage, especially plowing, also has a considerable effect in this connection.

Feeding Power of Plants.—Different species of plants exhibit a very great diversity in their ability to obtain plant food directly from the insoluble minerals of the soil. As a class, the legumes—especially such biennial and perennial legumes as red clover, sweet clover, and alfalfa—are endowed with unusual power to assimilate from mineral sources such elements as calcium and phosphorus, converting them into available forms for the crops that follow. For this reason it is especially advantageous to employ such legumes in connection with the application of limestone and rock phosphate. Thru their growth and subsequent decay large quantities of the mineral elements are liberated for

the benefit of the cereal crops which follow in the rotation. Moreover, as an effect of the deep-rooting habit of these legumes, mineral plant-food elements are brought up and rendered available from the vast reservoirs of the lower subsoil.

Effect of Limestone.—Limestone corrects the acidity of the soil and supplies calcium, thus encouraging the development not only of the nitrogen-gathering bacteria which live in the nodules on the roots of clover, cowpeas, and other legumes, but also the nitrifying bacteria, which have power to transform the unavailable organic nitrogen into available nitrate nitrogen. At the same time, the products of this decomposition have power to dissolve the minerals contained in the soil, such as potassium and magnesium compounds.

Organic Matter and Biological Action.—Organic matter may be supplied thru animal manures, consisting of the excreta of animals and usually accompanied by more or less stable litter; and by plant manures, including green-manure crops and cover crops plowed under, and also crop residues such as stalks, straw, and chaff. The rate of decay of organic matter depends largely upon its age, condition, and origin, and it may be hastened by tillage. The chemical analysis shows correctly the total organic carbon, which constitutes, as a rule, but little more than half the organic matter; so that 20,000 pounds of organic carbon in the plowed soil of an acre corresponds to nearly 20 tons of organic matter. But this organic matter consists largely of the old organic residues that have accumulated during the past centuries because they were resistant to decay, and 2 tons of clover or cowpeas plowed under may have greater power to liberate plant-food materials than 20 tons of old, inactive organic matter. The history of the individual farm or field must be depended upon for information concerning recent additions of active organic matter, whether in applications of farm manure, in legume crops, or in sods of old pastures.

The condition of the organic matter of the soil is indicated to some extent by the ratio of carbon to nitrogen. Fresh organic matter recently incorporated with the soil contains a very much higher proportion of carbon to nitrogen than do the old resistant organic residues of the soil. The proportion of carbon to nitrogen is higher in the surface soil than in the corresponding subsoil, and in general this ratio is wider in highly productive soils well charged with active organic matter than in very old, worn soils badly in need of active organic matter.

The organic matter furnishes food for bacteria, and as it decays certain decomposition products are formed, including much carbonic acid, some nitrous acid, and various organic acids, and these acting upon the soil have the power to dissolve the essential mineral plant foods, thus furnishing available phosphates, nitrates, and other salts of potassium, magnesium, calcium, etc., for the use of the growing crop.

Effect of Tillage.—Tillage, or cultivation, also hastens the liberation of plant-food elements by permitting the air to enter the soil. It should be remembered, however, that tillage is wholly destructive, in that it adds nothing whatever to the soil, but always leaves it poorer, so far as plant-food materials are concerned. Tillage should be practiced so far as is necessary to prepare a suitable seed bed for root development and also for the purpose of killing weeds, but more than

this is unnecessary and unprofitable; and it is much better actually to enrich the soil by proper applications of limestone, organic matter, and other fertilizing materials, and thus promote soil conditions favorable for vigorous plant growth, than to depend upon excessive cultivation to accomplish the same object at the expense of the soil.

PERMANENT SOIL IMPROVEMENT

According to the kind of soil involved, any comprehensive plan contemplating a permanent system of agriculture will need to take into account some of the following considerations.

The Application of Limestone

The Function of Limestone.—In considering the application of limestone to land it should be understood that this material functions in several different ways, and that a beneficial result may therefore be attributable to quite diverse causes. Limestone provides calcium, of which certain crops are strong feeders. It corrects acidity of the soil, thus making for some crops a much more favorable environment as well as establishing conditions absolutely required for some of the beneficial legume bacteria. It accelerates nitrification and nitrogen fixation. It promotes sanitation of the soil by inhibiting the growth of certain fungous diseases, such as corn-root rot. Experience indicates that it modifies either directly or indirectly the physical structure of fine-textured soils, frequently to their great improvement. Thus, working in one or more of these different ways, limestone often becomes the key to the improvement of worn lands.

Amounts to Apply.—Acid soils should be treated with limestone whenever such application is at all practicable. The initial application varies with the degree of acidity and will usually range from 2 to 6 tons an acre. The larger amounts will be needed on strongly acid soils, particularly on land being prepared for alfalfa. When sufficient limestone has been used to establish conditions favorable to the growth of legumes, no further applications are necessary until the acidity again develops to such an extent as to interfere with the best growth of these crops. This will ordinarily be at intervals of several years. In the case of an inadequate supply of magnesium in the soil, the occasional use of magnesian (dolomitic) limestone would serve to correct this deficiency. Otherwise, so far as present knowledge indicates, either form of limestone—high-calcium or magnesian—will be equally effective, depending upon the purity and fineness of the respective stones.

How to Ascertain the Need for Limestone.—One of the most reliable indications as to whether a soil needs limestone is the character of the growth of certain legumes, particularly sweet clover and alfalfa. These crops do not thrive in acid soils. Their successful growth, therefore, indicates the lack of sufficient acidity in the soil to be harmful. In case of their failure to grow the soil should be tested for acidity as described below. A very valuable test for ascertaining the need of a soil for limestone is found in the potassium thiocyanate test for soil acidity. It is desirable to make the test for carbonates along with the acidity test. Limestone is calcium carbonate, while dolomite is the combined carbonates

of calcium and magnesium. The natural occurrence of these carbonates in the soil is sufficient assurance that no limestone is needed, and the acidity test will be negative. On lands which have been treated with limestone, however, the surface soil may give a positive test for carbonates, owing to the presence of undecomposed pieces of limestone, and at the same time a positive test for acidity may be secured. Such a result means either that insufficient limestone has been added to neutralize the acidity, or that it has not been in the soil long enough to entirely correct the acidity. In making these tests, it is desirable to examine samples of soil from different depths, since carbonates may be present, even in abundance, below a surface stratum that is acid. Following are the directions for making the tests:

The Potassium Thiocyanate Test for Acidity. This test is made with a 4-percent solution of potassium thiocyanate in alcohol—4 grams of potassium thiocyanate in 100 cubic centimeters of 95-percent alcohol.[1] When a small quantity of soil shaken up in a test tube with this solution gives a red color the soil is acid and limestone should be applied. If the solution remains colorless the soil is not acid. An excess of water interferes with the reaction. The sample when tested, therefore, should be at least as dry as when the soil is in good tillable condition. For a prompt reaction the temperature of the soil and solution should be not lower than that of comfortable working conditions (60° to 75° Fahrenheit).

The Hydrochloric Acid Test for Carbonates. Take a small representative sample of soil and pour upon it a few drops of hydrochloric (muriatic) acid, prepared by diluting the concentrated acid with an equal volume of water. The presence of limestone or some other carbonates will be shown by the appearance of gas bubbles within 2 or 3 minutes, producing foaming or effervescence. The absence of carbonates in a soil is not in itself evidence that the soil is acid or that limestone should be applied, but it indicates that the confirmatory potassium thiocyanate test should be carried out.

The Nitrogen Problem

Nitrogen presents the greatest practical soil problem in American agriculture. Four important reasons for this are: its increasing deficiency in most soils; its cost when purchased on the open market; its removal in large amounts by crops; and its loss from soils thru leaching. Nitrogen usually costs from four to five times as much per pound as phosphorus. A 100-bushel crop of corn requires 150 pounds of nitrogen for its growth, but only 23 pounds of phosphorus. The loss of nitrogen from soils may vary from a few pounds to over one hundred pounds per acre, depending upon the treatment of the soil, the distribution of rainfall, and the protection afforded by growing crops.

An inexhaustible supply of nitrogen is present in the air. Above each acre of the earth's surface there are about sixty-nine million pounds of atmospheric nitrogen. The nitrogen above one square mile weighs twenty million tons, an amount sufficient to supply the entire world for four or five decades. This large supply of nitrogen in the air is the one to which the world must eventually turn.

There are two methods of collecting the inert nitrogen gas of the air and combining it into compounds that will furnish products for plant growth. These are the chemical and the biological fixation of the atmospheric nitrogen. Farmers have at their command one of these methods. By growing inoculated legumes, nitrogen may be obtained from the air, and by plowing under more than the roots of these legumes, nitrogen may be added to the soil.

[1] Since undenatured alcohol is difficult to obtain, some of the denatured alcohols have been tested for making this solution. Completely denatured alcohol made over U. S. Formulas No. 1 and No. 4_1 have been found satisfactory. Some commercial firms are also offering similar preparations which are satisfactory.

Inasmuch as legumes are worth growing for purposes other than the fixation of atmospheric nitrogen, a considerable portion of the nitrogen thus gained may be considered a by-product. Because of that fact, it is questionable whether the chemical fixation of nitrogen will ever be able to replace the simple method of obtaining atmospheric nitrogen by growing inoculated legumes in the production of our great grain and forage crops.

It may well be kept in mind that the following amounts of nitrogen are required for the produce named:

1 bushel of oats (grain and straw) requires 1 pound of nitrogen.
1 bushel of corn (grain and stalks) requires 1½ pounds of nitrogen.
1 bushel of wheat (grain and straw) requires 2 pounds of nitrogen.
1 ton of timothy contains 24 pounds of nitrogen.
1 ton of clover contains 40 pounds of nitrogen.
1 ton of cowpea hay contains 43 pounds of nitrogen.
1 ton of alfalfa contains 50 pounds of nitrogen.
1 ton of average manure contains 10 pounds of nitrogen.
1 ton of young sweet clover, at about the stage of growth when it is plowed under as green manure, contains, on water-free basis, 80 pounds of nitrogen.

The roots of clover contain about half as much nitrogen as the tops, and the roots of cowpeas contain about one-tenth as much as the tops. Soils of moderate productive power will furnish as much nitrogen to clover (and two or three times as much to cowpeas) as will be left in the roots and stubble. In grain crops, such as wheat, corn, and oats, about two-thirds of the nitrogen is contained in the grain and one-third in the straw or stalks.

The Phosphorus Problem

The element phosphorus is an indispensable constituent of every living cell. It is intimately connected with the life processes of both plants and animals, the nuclear material of the cells being especially rich in this element.

The phosphorus content of the soil is dependent upon the origin of the soil. The removal of phosphorus by continuous cropping slowly reduces the amount of this element in the soil available for crop use, unless its addition is provided for by natural means, such as overflow, or by agricultural practices, such as the addition of phosphatic fertilizers and rotations in which deep-rooting, leguminous crops are frequently grown.

It should be borne in mind in connection with the application of phosphate, or of any other fertilizing material, to the soil, that no benefit can result until the need for it has become a limiting factor in plant growth. For example, if there is already present in the soil sufficient available phosphorus to produce a forty-bushel crop, and the nitrogen supply or the moisture supply is sufficient for only forty bushels, or less, then extra phosphorus added to the soil cannot increase the yield beyond this forty-bushel limit.

There are several different materials containing phosphorus which are applied to land as fertilizer. The more important of these are bone meal, acid phosphate, natural raw rock phosphate, and basic slag. Obviously that carrier of phosphorus which gives the most economical returns, as considered from all standpoints, is the most suitable one to use. Altho this matter has been the subject of much discussion and investigation the question still remains unsettled. Probably there is no single carrier of phosphorus that will prove to be

the most economical one to use under all circumstances because so much depends upon soil conditions, crops grown, length of haul, and market conditions.

Bone meal, prepared from the bones of animals, appears on the market in two different forms, raw and steamed. Raw bone meal contains, besides the phosphorus, a considerable percentage of nitrogen which adds a useless expense if the material is purchased only for the sake of the phosphorus. As a source of phosphorus, steamed bone meal is preferable to raw bone meal. Steamed bone meal is prepared by extracting most of the nitrogenous and fatty matter from the bones, thus producing a more nearly pure form of calcium phosphate containing about 10 to 12 percent of the element phosphorus.

Acid phosphate is produced by treating rock phosphate with sulfuric acid. The two are mixed in about equal amounts; the product therefore contains about one-half as much phosphorus as the rock phosphate itself. Besides phosphorus, acid phosphate also contains sulfur, which is likewise an element of plant food. The phosphorus in acid phosphate is more readily available for absorption by plants than that of raw rock phosphate. Acid phosphate of good quality should contain 6 percent or more of the element phosphorus.

Rock phosphate, sometimes called floats, is a mineral substance found in vast deposits in certain regions. The phosphorus in this mineral exists chemically as tri-calcium phosphate and a good grade of the rock should contain 12½ percent, or more, of the element phosphorus. The rock should be ground to a powder, fine enough to pass thru a 100-mesh sieve, or even finer.

The relative cheapness of raw rock phosphate, as compared with the treated or acidulated material, makes it possible to apply for equal money expenditure considerably more phosphorus per acre in this form than in the form of acid phosphate, the ratio being, under the market conditions of the past several years, about 4 to 1. That is to say, under these market conditions, a dollar will purchase about four times as much of the element phosphorus in the form or rock phosphate as in the form of acid phosphate, which is an important consideration if one is interested in building up a phosphorus reserve in the soil. As explained above, more very carefully conducted comparisons on various soil types under various cropping systems are needed before definite statements can be given as to which form of phosphate is most economical to use under any given set of conditions.

Basic slag, known also as Thomas phosphate, is another carrier of phosphorus that might be mentioned because of its considerable usage in Europe and eastern United States. Basic slag phosphate is a by-product in the manufacture of steel. It contains a considerable proportion of basic material and therefore it tends to influence the soil reaction.

Rock phosphate may be applied at any time during a rotation, but it is applied to the best advantage either preceding a crop of clover, which plant seems to possess an unusual power for assimilating the phosphorus from raw phosphate, or else at a time when it can be plowed under with some form of organic matter such as animal manure or green manure, the decay of which serves to liberate the phosphorus from its insoluble condition in the rock. It is important that the finely ground rock phosphate be intimately mixed with the organic material as it is plowed under.

In using acid phosphate or bone meal in a cropping system which includes wheat, it is a common practice to apply the material in the preparation of the wheat ground. It may be advantageous, however, to divide the total amount to be used and apply a portion to the other crops of the rotation, particularly to corn and to clover.

The Potassium Problem

Our most common soils, which are silt loams and clay loams, are well stocked with potassium, altho it exists largely in a slowly soluble form. Such soils as sands and peats, however, are likely to be low in this element. On such soils this deficiency may be remedied by the application of some potassium salt, such as potassium sulfate, potassium chlorid, kainit, or other potassium compound, and in many instances this is done at great profit.

From all the facts at hand it seems, so far as our great areas of common soils are concerned, that, with a few exceptions, the potassium problem is not one of addition but of liberation. The Rothamsted records, which represent the oldest soil experiment fields in the world, show that for many years other soluble salts have had practically the same power as potassium salts to increase crop yields in the absence of sufficient decaying organic matter. Whether this action relates to supplying or liberating potassium for its own sake, or to the power of the soluble salt to increase the availability of phosphorus or other elements, is not known, but where much potassium is removed, as in the entire crops at Rothamsted, with no return of organic residues, probably the soluble salt functions in both ways.

Further evidence on this matter is furnished by the Illinois experiment field at Fairfield, where potassium sulfate has been compared with kainit both with and without the addition of organic matter in the form of stable manure. Both sulfate and kainit produced a substantial increase in the yield of corn, but the cheaper salt—kainit—was just as effective as the potassium sulfate, and returned some financial profit. Manure alone gave an increase similar to that produced by the potassium salts, but the salts added to the manure gave very little increase over that produced by the manure alone. This is explained in part, perhaps, by the fact that the potassium removed in the crops is mostly returned in manure properly cared for, and perhaps in larger part by the fact that decaying organic matter helps to liberate and hold in solution other plant-food elements, especially phosphorus.

In laboratory experiments at the Illinois Experiment Station, it has been shown that potassium salts and most other soluble salts increase the solubility of the phosphorus in soil and in rock phosphate; also that the addition of glucose with rock phosphate in pot-culture experiments increases the availability of the phosphorus, as measured by plant growth, altho the glucose consists only of carbon, hydrogen, and oxygen, and thus contains no limiting element of plant food.

In considering the conservation of potassium on the farm it should be remembered that in average live-stock farming the animals destroy two-thirds of the organic matter and retain one-fourth of the nitrogen and phosphorus from the food they consume, but that they retain less than one-tenth of the potassium;

so that the actual loss of potassium in the products sold from the farm, either in grain farming or in livestock farming, is negligible on land containing 25,000 pounds or more of potassium in the surface 6⅔ inches.

The Calcium and Magnesium Problem

When measured by crop removals of the plant-food elements, calcium is often more limited in Illinois soils than is potassium, while magnesium may be occasionally. In the case of calcium, however, the deficiency is likely to develop more rapidly and become much more marked because this element is leached out of the soil in drainage water to a far greater extent than is either magnesium or potassium.

The annual loss of limestone from the soil depends, of course, upon a number of factors aside from those which have to do with climatic conditions. Among these factors may be mentioned the character of the soil, the kind of limestone, its condition of fineness, the amount present, and the sort of farming practiced. Because of this variation in the loss of lime materials from the soil, it is impossible to prescribe a fixed practice in their renewal that will apply universally. The tests for acidity and carbonates described above, together with the behavior of such lime-loving legumes as alfalfa and sweet clover, will serve as general indicators for the frequency of applying limestone and the amount to use on a given field.

Limestone has a positive value on some soils for the plant food which it supplies, in addition to its value in correcting soil acidity and in improving the physical condition of the soil. Ordinary limestone (abundant in the southern and western parts of the state) contains nearly 800 pounds of calcium per ton; while a good grade of dolomitic limestone (the more common limestone of northern Illinois) contains about 400 pounds of calcium and 300 pounds of magnesium per ton. Both of these elements are furnished in readily available form in ground dolomitic limestone.

The Sulfur Question

In considering the relation of sulfur in a permanent system of soil fertility it is important to understand something of the cycle of transformations that this element undergoes in nature. Briefly stated this is as follows:

Sulfur exists in the soil in both organic and inorganic forms, the former being gradually converted to the latter form thru bacterial action. In this inorganic form sulfur is taken up by plants which in their physiological processes change it once more into an organic form as a constituent of protein. When these plant proteins are consumed by animals, the sulfur becomes a part of the animal protein. When these plant and animal proteins are decomposed, either thru bacterial action, or thru combustion, as in the burning of coal, the sulfur passes into the atmosphere or into the soil solution in the form of sulfur dioxid gas. This gas unites with oxygen and water to form sulfuric acid, which is readily washed back into the soil by the rain, thus completing the cycle, from soil—to plants and animals—to air—to soil.

In this way sulfur becomes largely a self-renewing element of the soil, altho there is a considerable loss from the soil by leaching. Observations taken at the

Illinois Agricultural Experiment Station show that 40 pounds of sulfur per acre are brought into the soil thru the annual rainfall. With a fair stock of sulfur, such as exists in our common types of soil, and with an annual return, which of itself would more than suffice for the needs of maximum crops, the maintenance of an adequate sulfur supply presents little reason at present for serious concern. There are regions, however, where the natural stock of sulfur in the soil is not nearly so high and where the amount returned thru rainfall is small. Under such circumstances sulfur soon becomes a limiting element of crop production, and it will be necessary sooner or later to introduce this substance from some outside source. Investigation is now under way to determine to what extent this situation may apply under Illinois conditions.

Physical Improvement of Soils

In the management of most soil types, one very important matter, aside from proper fertilization, tillage, and drainage, is to keep the soil in good physical condition, or good tilth. The constituent most important for this purpose is organic matter. Organic matter in producing good tilth helps to control washing of soil on rolling land, raises the temperature of drained soil, increases the moisture-holding capacity of the soil, slightly retards capillary rise and consequently loss of moisture by surface evaporation, and helps to overcome the tendency of some soils to run together badly.

The physical effect of organic matter is to produce a granulation or mellowness, by cementing the fine soil particles into crumbs or grains about as large as grains of sand, which produces a condition very favorable for tillage, percolation of rainfall, and the development of plant roots.

Organic matter is undergoing destruction during a large part of the year and the nitrates produced in its decomposition are used for plant growth. Altho this decomposition is necessary, it nevertheless reduces the amount of organic matter, and provision must therefore be made for maintaining the supply. The practical way to do this is to turn under the farm manure, straw, cornstalks, weeds, and all or part of the legumes produced on the farm. The amount of legumes needed depends upon the character of the soil. There are farms, especially grain farms, in nearly every community where all legumes could be turned under for several years to good advantage.

Manure should be spread upon the land as soon as possible after it is produced, for if it is allowed to lie in the barnyard several months as is so often the case, from one-third to two-thirds of the organic matter will be lost.

Straw and cornstalks should be turned under, and not burned. There is considerable evidence indicating that on some soils undecomposed straw applied in excessive amount may be detrimental. Probably the best practice is to apply the straw as a constituent of well-rotted stable manure. Perhaps no form of organic matter acts more beneficially in producing good tilth than cornstalks. It is true, they decay rather slowly, but it is also true that their durability in the soil is exactly what is needed in the production of good tilth. Furthermore, the nitrogen in a ton of cornstalks is one and one-half times that of a ton of manure, and a ton of dry cornstalks incorporated in the soil will ultimately

furnish as much humus as four tons of average farm manure. When burned, however, both the humus-making material and the nitrogen are lost to the soil.

It is a common practice in the corn belt to pasture the cornstalks during the winter and often rather late in the spring after the frost is out of the ground. This trampling by stock sometimes puts the soil in bad condition for working. It becomes partially puddled and will be cloddy as a result. If tramped too late in the spring, the natural agencies of freezing and thawing and wetting and drying, with the aid of ordinary tillage, fail to produce good tilth before the crop is planted. Whether the crop is corn or oats, it necessarily suffers, and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats, the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling which is unfavorable to physical, chemical, and biological processes. The effect becomes worse if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Systems of Crop Rotations

In a program of permanent soil improvement one should adopt at the outset a good rotation of crops, including, for the reasons discussed above, a liberal use of legumes. No one can say in advance for every particular case what will prove to be the best rotation of crops, because of variation in farms and farmers and in prices for produce.

Following are a few suggested rotations which may serve as models or outlines to be modified according to special circumstances.

Six-Year Rotations

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover), or grass and clover
Sixth year —Clover, or clover and grass

Of course there should be as many fields as there are years in the rotation. In grain farming, with small grain grown the third and fifth years, most of the unsalable products should be returned to the soil, and the clover may be clipped and left on the land or returned after threshing out the seed (only the clover seed being sold the fourth and sixth years); or, in livestock farming, the field may be used three years for timothy and clover pasture and meadow if desired. The system may be reduced to a five-year rotation by cutting out either the second or the sixth year, and to a four-year system by omitting the fifth and sixth years, as indicated below.

Five-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover, or clover and grass)
Third year —Clover, or clover and grass
Fourth year —Wheat (with clover), or clover and grass
Fifth year —Clover, or clover and grass

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover)

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover
Fifth year —Wheat (with clover)

The last rotation mentioned above allows legumes to be grown four times. Alfalfa may be grown on a sixth field for five or six years in the combination rotation, alternating between two fields every five years, or rotating over all the fields if moved every six years.

Four-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover)
Third year —Clover
Fourth year —Wheat (with clover)

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover)
Fourth year —Clover

First year —Wheat or oats (with clover)
Second year —Clover
Third year —Corn
Fourth year —Oats (with clover)

Alfalfa may be grown on a fifth field for four or eight years, which is to be alternated with one of the four; or the alfalfa may be moved every five years, and thus rotated over all five fields every twenty-five years.

Three-Year Rotations

First year —Corn
Second year —Oats or wheat (with clover)
Third year —Clover

First year —Wheat or oats (with clover)
Second year —Corn
Third year —Cowpeas or soybeans

By allowing the clover, in the last rotation mentioned, to grow in the spring before preparing the land for corn, we have provided a system in which legumes grow on every acre every year. This is likewise true of the following suggested two-year system:

Two-Year Rotations

First year —Oats or wheat (with sweet clover)
Second year —Corn

Altho in this two-year rotation either oats or wheat is suggested, as a matter of fact, by dividing the land devoted to small grain, both of these crops can be grown simultaneously, thus providing a three-crop system in a two-year cycle.

It should be understood that in all of the above suggested cropping systems it may be desirable in some cases to substitute rye for the wheat or oats. Or, in some cases, it may become desirable to divide the acreage of small grain and grow in the same year more than one kind. In all of these proposed rotations the word *clover* is used in a general sense to designate either red clover, alsike clover, or sweet clover. The value of sweet clover, especially as a green manure for building up depleted soils, as well as a pasture and hay-crop, is becoming thoroly established, and its importance in a crop-rotation program may well be emphasized.

SUPPLEMENT: EXPERIMENT FIELD DATA

(Results from Experiment Fields on Soil Types Similar to those Occurring in Randolph County)

The University of Illinois has operated altogether about fifty soil experiment fields in different sections of the state and on various types of soil. Altho some of these fields have been discontinued, the large majority are still in operation. It is the present purpose to report the summarized results from certain of these fields located on types of soil described in the accompanying soil report.

A few general explanations at this point, which apply to all the fields, will relieve the necessity of numerous repetitions in the following pages.

Size and Arrangement of Fields

The soil experiment fields vary in size from less than two acres up to 40 acres or more. They are laid off into series of plots, the plots commonly being either one-fifth or one-tenth acre in area. Each series is occupied by one kind of crop. Usually there are several series so that a crop rotation can be carried on with every crop represented every year.

Farming Systems

On many of the fields the treatment provides for two distinct systems of farming, livestock farming and grain farming.

In the livestock system, stable manure is used to furnish organic matter and nitrogen. The amount applied to a plot is based upon the amount that can be produced from crops raised on that plot.

In the grain system no animal manure is used. The organic matter and nitrogen are applied in the form of plant manures, including the plant residues produced, such as corn stalks, straw from wheat, oats, clover, etc., along with leguminous catch crops plowed under. It is the plan in this latter system to remove from the land, in the main, only the grain and seed produced, except in the case of alfalfa, that crop being harvested for hay the same as in the livestock system.

Crop Rotations

Crops which are of interest in the respective localities are grown in definite rotations. The most common rotation used is wheat, corn, oats, and clover; and often these crops are accompanied by alfalfa growing on a fifth series. In the grain system a legume catch crop, usually sweet clover, in included, which is seeded on the young wheat in the spring and plowed under in the fall or in the following spring in preparation for corn. If the red clover crop fails, soybeans are substituted.

Soil Treatment

The treatment applied to the plots has, for the most part, been standardized according to a rather definite system, altho deviations from this system occur now and then, particularly in the older fields.

Following is a brief explanation of this standard system of treatment.

Animal manures.—Animal manures, consisting of excreta from animals, with stable litter, are spread upon the respective plots in amounts proportionate to previous crop yields, the applications being made in the preparation for corn.

Plant Manures.—Crop residues produced on the land, such as stalks, straw, and chaff, are returned to the soil, and in addition a green-manure crop of sweet clover is seeded in small grains to be plowed under in preparation for corn. (On plots where limestone is lacking the sweet clover seldom survives.) This practice is designated as the *residues system.*

Mineral Manures.—The yearly acre-rates of application have been: for limestone, 1,000 pounds; for raw rock phosphate, 500 pounds; and for potassium, usually 200 pounds of kainit. When kainit was not available, owing to conditions brought on by the World war, potassium carbonate was used. The initial application of limestone has usually been 4 tons per acre.

Explanation of Symbols Used

0 = Untreated land or check plots
M = Manure (animal)
R = Residues (from crops, and includes legumes used as green manure)
L = Limestone
P = Phosphorus, in the form of rock phosphate unless otherwise designated (aP = acid phosphate, bP = bonemeal, rP = rock phosphate, sP = slag phosphate)
K = Potassium (usually in the form of kainit)
N = Nitrogen (usually in the form contained in dried blood)
Le = Legume used as green manure
Cv = Cover crop
( ) = Parentheses enclosing figures signify tons of hay, as distinguished from bushels of seed

In discussions of this sort of data, financial profits or losses based upon assigned market values are frequently considered. However, in view of the erratic fluctuations in market values—especially in the past few years—it seems futile to attempt to set any prices for this purpose that are at all satisfactory. The yields are therefore presented with the thought that with these figures at hand the financial returns from a given practice can readily be computed upon the basis of any set of market values that the reader may choose to apply.

THE SPARTA FIELD

A University soils experiment field is located in Randolph county immediately north of Sparta. This field has been in operation since 1916. It comprizes 20 acres of light-colored, loessial soils characteristic of the region. The county map indicates the presence of two soil types—Light Gray Silt Loam On Tight Clay and Yellow-Gray Silt Loam. However, with accumulating ex-

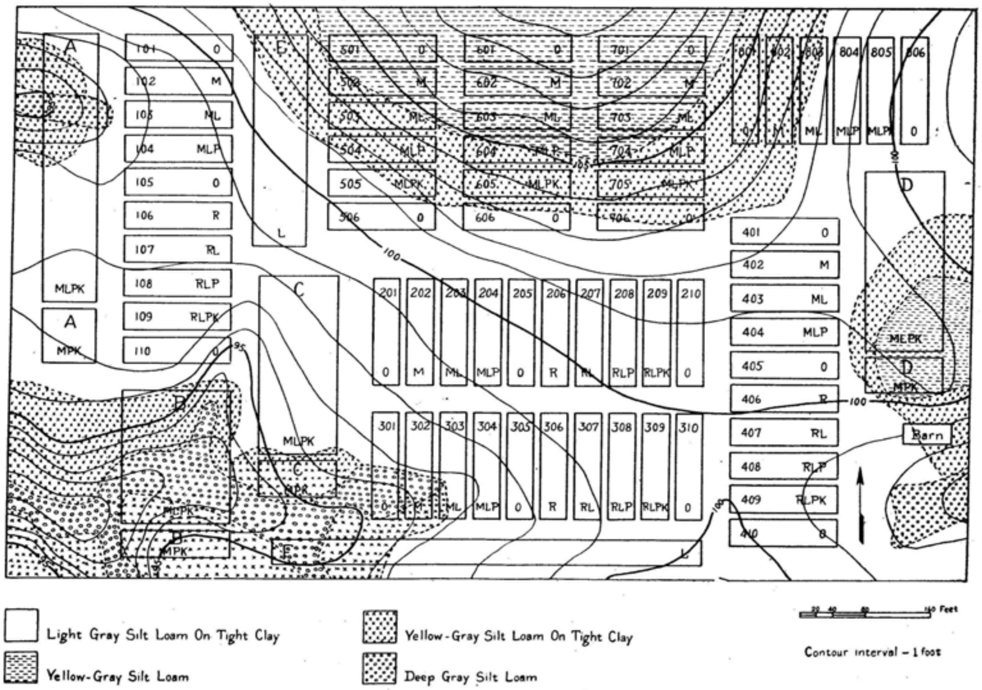

FIG. 2.—DIAGRAM OF SPARTA FIELD

This diagram shows the five separate systems of plots maintained on this field, the soil treatments applied, the location of the different soil types, and, by means of contour lines, the natural drainage of the field.

perience in the soil survey, certain characteristics have come to attention which formerly were not recognized and which, in some instances, call for reclassification of types. Thus it happens that a closer examination of this field reveals the presence of small areas of two additional soil types—Yellow-Gray Silt Loam On Tight Clay and Deep Gray Silt Loam. The distribution of these soil types, as well as the arrangement of plots, is charted on the accompanying diagram (Fig. 2). The topography of the land is also indicated on the diagram by contour lines.

The field is laid out into five separate systems of plots, each system with its own program of crop rotation.

The 100, 200, 300, and 400 Series

The four series of plots designated as 100, 200, 300, and 400, with the exception of parts of two plots, all lie on the soil type mapped as Light Gray Silt Loam On Tight Clay. They are under a crop rotation of corn, soybeans, wheat, and clover (chiefly sweet clover). Until 1921 it was the practice to seed cowpeas as a cover crop in the corn on the residues plots. The soil treatments are as indicated in the accompanying diagram and tables, and they have been applied in the manner previously described, with the exception that the initial application of limestone was 5 tons an acre and in 1922 the periodic application of this material was discontinued until its further need should become apparent.

TABLE 7.—SPARTA FIELD: SERIES 100, 200, 300, 400
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1916 Corn[1]	1917 Soy-beans[4]	1918 Wheat[4]	1919 Soy-beans[4]	1920 Corn	1921 Soy-beans	1922 Wheat	1923 Sweet clover	1924 Corn	1925 Soy-beans
101	0..........	14.8	(.99)	7.3	(.85)	8.6	5.5	11.2	0.00	2.0	(.72)
102	M..........	18.2	(1.05)	7.7	(.92)	13.6	5.8	8.5	0.00	.3	(.79)
103	ML........	16.8	(1.33)	12.3	(1.38)	21.6	11.7	15.7	.50	17.4	(1.71)
104	MLrP......	19.8	(1.36)	15.3	(1.38)	21.8	10.5	15.8	.41	17.2	(1.85)
105	0..........	13.8	5.8	2.7	..[5]	11.0	4.7	4.2	0.00	.3	(.65)
106	R..........	16.6	9.2	5.2	..[5]	13.8	6.0	4.2	0.00	.9	(.88)
107	RL.........	21.2	9.8	13.2	..[5]	11.4	10.8	13.7	.41	27.8	(1.51)
108	RLrP.......	20.0	9.5	13.0	..[5]	8.6	9.5	12.0	.22	27.8	(1.74)
109	RLrPK.....	18.6	11.3	16.7	..[5]	20.6	10.0	16.0	.44	32.0	(1.85)
110	0..........	17.4	(.99)	4.2	(.75)	9.4	5.5	3.5	0.00	1.2	(1.07)
		Soy-beans[1]	Corn	Soy-beans	Wheat	Clover	Corn	Soy-beans	Wheat	Sweet clover	Corn
201	0..........	(1.37)	28.0	(.58)	2.8	(0.00)	34.2	3.5	2.7	0.00	26.8
202	M..........	(1.16)	31.4	(.80)	3.2	(0.00)	30.6	5.0	4.2	0.00	39.2
203	ML........	(1.41)	49.4	(1.15)	20.2	(1.66)	42.0	8.3	14.0	.50	53.6
204	MLrP......	(1.60)	49.4	(1.05)	20.0	(1.73)	41.8	8.3	13.8	.17	62.0
205	0..........	7.7	28.2	7.0	2.7	0.00	22.8	3.3	2.2	0.00	19.2
206	R..........	7.2	36.0	6.3	2.3	0.00	28.2	3.7	2.0	0.00	23.0
207	RL.........	10.3	35.0	9.7	20.0	1.50	22.4	8.3	10.0	.17	48.8
208	RLrP.......	8.8	39.0	11.0	22.5	1.87	22.2	8.5	11.7	.17	51.4
209	RLrPK.....	9.7	47.0	9.3	21.0	1.69	23.8	8.7	17.8	.33	66.0
210	0..........	(.96)	28.0	(.55)	2.8	(0.00)	2.8	3.2	3.7	0.00	17.0
		Wheat[2]	Soy-beans[4]	Corn	Soy-beans	Wheat	Sweet clover	Corn	Soy-beans	Wheat	Sweet clover
301	0..........	6.3	(.76)	1.0	(1.12)	10.8	0.00	19.4	9.3	.8	0.00
302	M..........	6.7	(.85)	3.2	(1.40)	20.5	0.00	23.8	12.0	2.0	0.00
303	ML........	9.0	(.70)	5.0	(2.00)	27.2	1.00	33.0	25.7	2.8	3.18
304	MLrP......	8.2	(.63)	4.4	(2.02)	27.5	1.33	31.8	24.5	3.5	1.98
305	0..........	1.8	3.3	.4	..[5]	8.8	0.00	6.4	3.5	.3	0 00
306	R..........	3.7	4.7	.4	..[5]	9.7	0.00	11.2	7.3	.5	0.00
307	RL.........	8.8	8.8	.2	..[5]	20.8	.83	19.8	22.7	6.5	2.27
308	RLrP.......	9.2	9.7	.2	..[5]	22.2	.83	19.2	25.7	5.7	2.83
309	RLrPK.....	11.0	8.3	.2	..[5]	26.7	1.00	19.8	21.7	7.2	4.50
310	0..........	5.0	(.66)	.1	(.42)	5.2	0.00	8.4	5.0	.5	0.00
		Soy-beans[3]	Wheat[4]	Clover[4]	Corn	Soy-beans	Wheat	Sweet clover	Corn	Soy-beans	Wheat
401	0..........	(.48)	10.5	(0.00)	5.4	(.48)	6.7	0.00	15.0	2.0	3.0
402	M..........	(.67)	15.0	(0.00)	4.6	(.62)	9.2	0.00	28.0	4.7	6.7
403	ML........	(.73)	24.2	(1.15)	3.0	(.88)	19.0	2.83	42.8	14.3	20.7
404	MLrP......	(.80)	27.2	(1.55)	4.4	(1.00)	17.8	3.00	44.2	14.8	25.7
405	0..........	5.2	18.8	0.00	9.0	6.7	12.5	0.00	23.0	4.5	7.8
406	R..........	6.3	17.2	0.00	9.8	6.2	11.2	0.00	23.8	4.5	8.3
407	RL.........	8.0	23.5	2.92	10.6	11.3	17.5	2.17	34.0	11.5	24.7
408	RLrP.......	6.0	25.3	2.75	10.2	12.8	19.2	3.00	32.4	11.8	26.5
409	RLrPK.....	6.5	23.5	3.67	14.6	14.8	17.2	3.00	39.2	14.8	22.2
410	0..........	(.61)	16.2	(0.00)	9.6	5.2	11.0	0.00	25.8	2.0	5.8

The heavier rules mark the beginning of full soil treatment.

[1]Lime and phosphorus only. [2]No residues or manure. [3]No residues, manure, or potassium. [4]No manure. [5]Harvested for seed but destroyed by continuous rain.

TABLE 8.—SPARTA FIELD, SERIES 100, 200, 300, AND 400: SUMMARY OF CROP YIELDS
Average Annual Yields—Bushels or (tons) per acre

Serial Plot No.	Soil treatment applied	Corn	Soybeans		Wheat	Clover	Sweet clover seed
			Hay	Seed			
		9 crops	*4 crops*	*4 crops*	*7 crops*	*1 crop*	*5 crops*
1	0	15.6	(.73)	5.1	5.4	(0.00)	0.00
2	M	19.4	(.90)	6.9	7.8	(0.00)	0.00
3	ML	29.8	(1.44)	15.0	17.1	(1.66)	1.60
4	MLP	30.8	(1.48)	14.5	17.7	(1.73)	1.38
			1 crop	*6 crops*			
5	0	13.4	(.65)	5.0	5.5	0.00	0.00
6	R	16.3	(.88)	5.7	5.5	0.00	0.00
7	RL	23.3	(1.51)	12.4	16.2	1.50	1.17
8	RLP	23.4	(1.74)	13.2	17.1	1.87	1.43
9	RLPK	29.2	(1.85)	13.2	18.3	1.69	1.86
			3 crops	*5 crops*			
10	0	11.4	(.68)	4.2	4.6	(0.00)	0.00

Table 7 records the yields of all crops grown on these series, and in Table 8 is a summary of the results showing the average annual yields for the different kinds of crops, including the years that the complete soil treatments have been in effect.

The low yields on the untreated plots testify to the natural poverty of this soil, altho this particular piece of land, on account of its favorable location with respect to drainage, is rather more productive than the general run of the type that it represents.

Neither manure nor residues, used alone, has much effect toward crop improvement. A sharp increase, however, follows the application of limestone used with either manure or residues. Without limestone, clover refuses to grow; with limestone, fair crops of clover have been obtained. Rock phosphate has produced no significant effect, whether used with manure or with residues.

Potassium seems to have been of some benefit to the corn but not to the

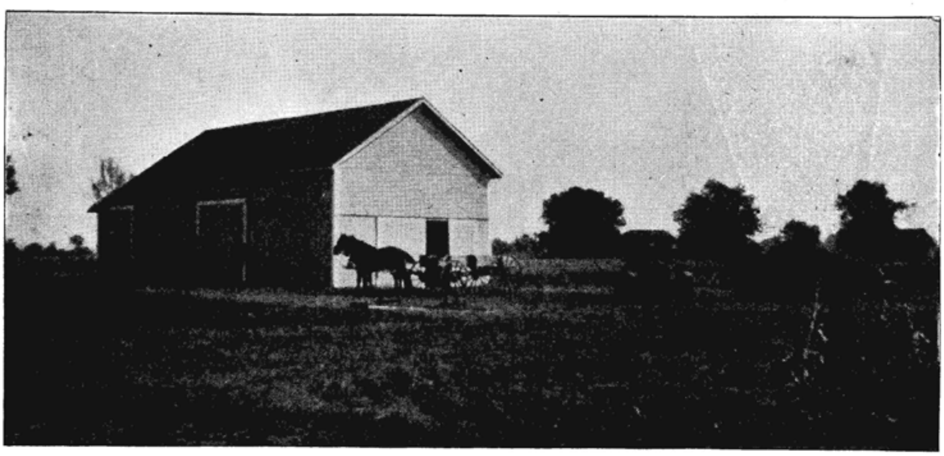

FIG. 3.—CORNER OF THE SPARTA EXPERIMENT FIELD

A field of 20 acres representative of land in the vicinity is devoted to experiments designed to find ways and means of building up the fertility of the soil.

other crops. It is questionable, however, whether the increase in corn yield would cover the cost of material as it was used in these experiments. It is possible that smaller quantities applied direct to the corn crop would prove a more economical way to use potassium fertilizer on this soil.

The 500, 600, 700, and 800 Series

The 500, 600, 700, and 800 series constitute another system of plots, under another program of cropping. The yields of all crops harvested on these plots are recorded in Table 9. These yields are not summarized, for the reason that the changes in the cropping system, together with the natural soil variations of these plots (see Fig. 2), have complicated conditions so that comparisons of averages at this time would scarcely have significance. The records of these plots, however, do contain some matters of practical interest that are worthy of attention.

The cropping program on these plots for several years included potatoes, wheat, and clover, rotating on three of the series, while alfalfa occupied the fourth series. In 1921 the rotation was changed to wheat, oats, sweet clover, and potatoes, with sweet clover seeded as a catch crop in the wheat. In 1924

TABLE 9.—SPARTA FIELD: SERIES 500, 600, 700, 800
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
		Soybeans[1]	Potatoes	Wheat	Clover	Potatoes	Wheat	Oats	Sweet clover	Corn	Cowpea hay
501	0	(1.28)	25.5	12.8	(0.00)	30.2	17.5	1.9	0.00	25.0	(1.13)
502	M	(1.20)	35.0	17.2	(0.00)	46.2	17.7	3.8	0.00	37.2	(1.27)
503	ML	(1.28)	34.0	21.3	(1.22)	64.8	19.7	4.4	.82	52.8	(2.03)
504	MLrP	(1.22)	33.5	23.5	(1.63)	21.7	23.0	1.9	.71	38.2	(2.26)
505	MLrPK	(1.20)	23.3	23.5	(1.91)	0.0	24.3	1.3	1.14	25.4	(2.82)
506	0	(1.07)	12.2	14.3	(0.00)	0.0	21.8	.9	0.00	3.0	(1.87)
			Alfalfa[2]	Alfalfa[2]	Alfalfa[2]	Alfalfa[2]	Potatoes	Wheat	Oats / Stubble clover	Cowpea hay	Timothy-Clover hay
601	0	......	(.49)	(1.54)	(1.03)	(1.56)	39.5	11.0	21.9 / (0.00)	(1.09)	(.43)
602	M	......	(.58)	(1.80)	(1.10)	(1.70)	43.5	11.3	27.5 / (0.00)	(1.54)	(.86)
603	ML	......	(3.23)	(4.32)	(2.18)	(3.10)	51.3	15.0	31.3 / (.96)	(1.99)	(1.67)
604	MLrP	......	(3.25)	(3.67)	(2.00)	(2.40)	41.0	18.7	32.5 / (.99)	(1.74)	(1.76)
605	MLrPK	......	(1.72)	(2.96)	(1.27)	(1.01)	26.0	12.7	26.3 / (.94)	(1.45)	(1.50)
606	0	......	(0.00)	(0.00)	(0.00)	(0.00)	5.5	4.2	6.6 / (0.00)	(.41)	(.26)
		Wheat[1]	Soybeans[2]	Potatoes	Wheat	Clover	Oats	Potatoes	Wheat	Sweet clover	Wheat
701	0	5.7	(1.51)	10.3	10.3	(0.00)	19.1	30.0	8.5	(0.00)	10.8
702	M	5.3	(1.52)	13.8	10.5	(0.00)	27.5	37.8	11.7	(0.00)	15.8
703	ML	5.2	(1.89)	20.7	16.0	(1.76)	55.0	51.7	16.2	(1.80)	28.3
704	MLrP	4.0	(1.80)	16.0	18.8	(1.59)	57.5	53.0	20.8	(2.60)	38.2
705	MLrPK	3.0	(1.89)	6.7	17.8	(1.59)	53.4	43.3	21.3	(2.80)	40.8
706	0	.3	(.91)	3.3	6.3	(.43)	17.8	18.3	5.7	(.13)	9.2
		Potatoes[1]	Wheat[2]	Clover[2]	Potatoes	Wheat	Clover	Soybeans	Corn	Wheat	Corn
801	0	30.3	24.8	(.72)	20.0	10.0	(0.00)	3.3	7.6	2.8	15.0
802	M	25.5	20.5	(.72)	32.7	15.8	(0.00)	3.7	9.2	3.2	14.6
803	ML	30.5	22.0	(.95)	26.2	19.2	(1.02)	6.3	16.8	7.8	58.2
804	MLrP	17.2	27.2	(.95)	4.2	20.2	(1.18)	5.7	16.4	8.7	68.0
805	MLrPK	17.2	30.2	(1.50)	1.8	25.2	(1.13)	7.0	16.4	11.7	63.2
806	0	32.0	22.3	(0.00)	1.3	11.2	(.54)	3.3	9.6	4.0	20.6

The heavier rules mark the beginning of full soil treatment; the double rule indicates a change in the cropping system.

[1]Lime and phosphorus only. [2]No manure.

another change was made whereby a rotation of corn, cowpeas, clover-timothy mixture, and wheat with sweet clover catch crop, was adopted.

It is of interest to observe that in the four years of the test on the 600 series, very fair crops of alfalfa were produced where limestone was applied, altho it is to be noted that, with its somewhat rolling topography, this piece of land is favorably situated for alfalfa.

Another point brought out by these data is that this land is not adapted to potato growing. In the seven years' experience only poor yields were obtained even on the best treated plots.

TABLE 10.—SPARTA FIELD: PLOTS A, B, C, D
Annual Crop Yields—Bushels or (tons) per acre

Plot	Soil treatment applied	1916 Alfalfa seeding[1]	1917 Alfalfa[1]	1918 Alfalfa[1]	1919 Alfalfa[1]		1920 Alfalfa[1]		1921 Soybeans[1]		1922 Wheat	1923 Oats	1924 Corn	1925 Wheat
A	MLrPK.......	....	(2.72)	(3.12)	(.94)		(.27)		13.7		18.9	27.6	23.8	21.2
A	MrPK.......	....	(0.00)	(0.00)	(0.00)		(0.00)		4.0		13.2	5.3	.5	14.5
		Wheat[1]	Winter oats[1]	Sweet clover[1]	Wheat		Winter oats	Stubble clover	Sweet clover		Alfalfa	Alfalfa	Alfalfa	Corn
B	MLrPK.....	5.0	2.4	(1.50)	17.7		37.8	(1.12)	1.57		(2.89)	(3.45)	(2.61)	58.7
B	MrPK.......	5.5	2.5	(0.00)	10.3		38.8	(0.00)	.33		(1.20)	(1.62)	(1.45)	38.2
		Soybeans[1]	Wheat	Winter oats[2]	Sweet clover		Wheat		Winter oats	Stubble clover	Sweet clover	Wheat	Alfalfa	Alfalfa
C	MLrPK.....	5.3	33.5	....	(1.58)		24.7		53.1	(.73)	3.30	25.5	(2.97)	(3.07)
C	MrPK.......	5.7	21.3	....	(0.00)		12.2		29.4	(0.00)	.97	9.5	(2.13)	(1.66)
		Oats[1]	Sweet clover[1]	Wheat	Winter oats	Stubble clover	Sweet clover		Wheat		Oats	Sweet clover	Wheat	Alfalfa
D	MLrPK.....	15.2	(1.21)	22.4	39.5	(1.58)	.67		23.8		6.9	.68	16.8	(2.50)
D	MrPK.......	25.0	(0.00)	18.2	36.2	(0.00)	0.00		15.5		4.7	.65	14.2	(1.72)

The heavier rules mark the beginning of full soil treatment.
[1]No manure. [2]Crop failure.

Plots A, B, C, and D

Plots A, B, C, and D are irregular in size and shape, being distributed about the field in odd spaces among the other series. Each plot is treated with manure, limestone, rock phosphate, and potassium salt. A small area, or subplot, for each plot remains without limestone. A rotation of wheat, winter oats, and sweet clover on three of the plots, with alfalfa remaining four years on the fourth plot, was followed for the first few years. In 1921 a slight change was made, spring oats being substituted for winter oats. In 1923 alfalfa was introduced on a second plot. The regular applications of limestone were discontinued in 1922.

Because of irregularities in soil type and changes in cropping, no attempt is made at this time to summarize the results from these plots. The annual yields, however, are given in detail in Table 10, as a matter of record.

FIG. 4.—SWEET CLOVER GROWING ON THE SPARTA FIELD

These two plots in the same series were seeded alike to sweet clover. The application of limestone was the principal factor in the difference in results. Without limestone sweet clover will not grow on this land.

Plots E and F

Plots E and F were laid out in 1920. They were treated with limestone at the rate of 5 tons an acre. Small grains and legumes have been grown alternately, but otherwise no definite plan of crop rotation has been followed. The plots have served mainly for variety tests rather than for any special soil investigations. For the sake of any information of interest that may be contained, the crop yields are placed on record in Table 11.

TABLE 11.—SPARTA FIELD: PLOTS E AND F
Annual Crop Yields—Bushels or (tons) per acre

Plot	Soil treatment applied	1920	1921	1922	1923	1924	1925
E	Limestone......	Oat hay (.17)	Sweet clover .63	Soybeans 8.0	Wheat 17.8	Sweet clover 2.75	Wheat 17.3
F	Limestone......	Winter barley 18.1	Sweet clover .67	Wheat 14.5	Sweet clover .64	Wheat 12.0	Oats 19.3

THE ODIN FIELD

An experiment field was established at Odin in Marion county in 1902. The field is located mainly on Gray Silt Loam On Tight Clay. A detailed examination, however, shows the presence of Gray Silt Loam On Compact Red Clay in the northwest corner of the field. There is also a very small patch of Yellow-Gray Silt Loam located on the border, so that it should not materially affect the plots proper.

A part of the field is tile-drained, but owing to the impervious nature of the subsoil satisfactory results have not been obtained from the tiling.

The field is laid off into different systems of plots as described below.

Series 100, 200, 300, and 400

The rotation chiefly practiced on Series 100, 200, 300, and 400 has been corn, legumes (cowpeas or soybeans), wheat, and clover. Until 1922 the clover was alsike, soybeans being substituted if the clover failed. Since that time sweet clover has been used instead of alsike. A part of the time cowpeas were seeded in the corn, at the last cultivation. The first five plots in each series were not tile-drained, while the last five plots were tile-drained.

Phosphorus was applied in the form of steamed bone meal, used at the rate of 200 pounds an acre a year until 1923, when the total application of the bone meal was evened up on all plots to 4,800 pounds an acre and temporarily discontinued. Potassium was applied at the annual rate of 100 pounds an acre of potassium sulfate until 1923. At that time the total application was evened up to 2,500 pounds on each of the potassium plots, and plans made to continue the application on the southwest halves of the plots at the normal rate.

In 1902 slaked lime at the acre rate of 475 pounds was applied to the limed plots, and in 1903 an additional 2 tons was applied to these plots. No more lime was added until 1908, after which it was applied regularly at the annual rate of 500 pounds of limestone an acre to the northwest halves and 1,000 pounds an acre to the southeast halves of these plots. In 1922 these applications were temporarily discontinued until further need for lime appears.

Crop residues and cover crops have been regularly plowed down on the residue plots. The return of the wheat straw was discontinued in 1922. From 1907 to 1919 the northeast half of each plot was subsoiled at the time of plowing for corn.

Table 12 summarizes the yields, by crops, for the period during which the plots have been under their full fertilizer treatment. The lower section of the table gives a more condensed summary in terms of crop increases, indicating the effects of the different fertilizing materials as they were used in these experiments. These figures are based upon the results of the corresponding tiled and untiled plots averaged together.

Organic manure is provided in these experiments by plowing under crop residues and legume crops used as green manure. The crop yields show little effect from residues alone. Residues with limestone, however, have produced, with a single exception, notable increases in yields. It is of interest to note that the one crop which does not show a benefit from limestone is cowpeas, and the cowpea is generally known as a plant tolerant to soil acidity.

Regarding the phosphorus treatment on these series it will be observed that wheat shows a very marked benefit from bone meal, but the other crops have responded indifferently. With a single exception, the potassium treatment has been attended by some increase in yield, and in the case of the corn this increase is very pronounced.

These results on the whole point to the necessity of using limestone in connection with organic manures in improving this soil. On the farm, all available stable manure should be utilized.

TABLE 12.—ODIN FIELD: AVERAGE ANNUAL CROP YIELDS, 1903-1925
Bushels or (tons) per acre

Serial Plot No.	Soil treatment applied[1]	Corn	Soybeans	Wheat	Alsike clover		Sweet clover	Stubble clover	Cowpeas	
					Hay	Seed			Hay	Seed
		22 crops	*19 crops*	*23 crops*	*2 crops*	*1 crop*	*3 crops*	*2 crops*	*8 crops*	*1 crop*
1	0	22.8	8.1	9.5	(.11)	.42	0.00	(0.00)	(.58)	1.7
2	R	23.5	9.3	9.3	(.14)	1.25	.06	(0.00)	(.62)	2.9
3	RL	27.1	10.9	17.5	(.99)	1.67	1.71	(.70)	(.57)	2.5
4	RLP	27.1	10.3	22.5	(1.10)	1.67	1.10	(.70)	(.64)	2.3
5	RLPK	43.7	13.3	25.8	(1.87)	1.83	1.76	(.90)	(1.11)	4.6
6	0	17.7	6.4	7.2	(.19)	.92	0.00	(0.00)	(.52)	1.4
7	R	22.0	7.7	10.6	(.18)	1.50	.08	(0.00)	(.62)	2.3
8	RL	27.5	10.8	17.6	(1.07)	3.08	.99	(.41)	(.61)	2.7
9	RLP	29.0	10.6	23.8	(1.12)	2.83	.76	(.48)	(.71)	1.8
10	RLPK	40.5	13.0	25.6	(1.65)	2.00	1.37	(.78)	(1.11)	3.9
	R over 0	2.5	1.3	1.6	(.01)	.71	.07	(0.00)	(.07)	.1
	RL over R	4.6	2.4	7.6	(.87)	1.00	1.28	(.56)	(−.03)	0.0
	RLP over RL	.8	−.4	5.6	(.08)	−.13	−.42	(.04)	(.09)	−.6
	RLPK over RLP	14.1	2.7	2.7	(.65)	−.34	.59	(.25)	(.44)	2.3

[1]Plots 1 to 5 not tiled; Plots 6 to 10 tiled.

Comparative Phosphate Tests

Series 500, 600, 700, and 800 were originally plotted as one series of six long plots for the purpose of studying the relative value of various carriers of phosphorus used in equal money values on limed and unlimed land.

A rotation of corn, oats, and three years of clover-timothy meadow was first established on this series. Cowpeas were seeded in the corn for use as residues. The phosphates were applied at the annual acre rate of 200 pounds of steamed bone meal, 333 pounds of acid phosphate, 666 pounds of rock phosphate, and 250 pounds of slag phosphate. At that time these amounts were of equivalent money value. The first application of lime was at the acre rate of 1½ tons to the southeast halves. Subsequent applications were at the annual acre rate of 1,000 pounds. Potassium at the annual acre rate of 100 pounds of potassium sulfate was applied to all plots. These applications were discontinued in 1913.

The results on these plots are summarized by crops in Table 13. The lower part of the table shows differences in crop yields presumed to have resulted from applying the various forms of phosphatic fertilizers for all the crops harvested from 1904 up to 1921, after which time the plots were modified.

Altho it is recognized that these data are too meagre for final conclusions, the following comments based upon these figures for crop increases may be made. It appears that the various phosphorus carriers—bone meal, acid phosphate, rock phosphate, and slag phosphate—rank differently in efficiency, according

TABLE 13.—ODIN FIELD: COMPARATIVE PHOSPHATE TESTS
Summary of Crop Yields 1904-1921—Bushels or (tons) per acre

Plot No.	Soil treatment applied	Corn *4 crops*	Oats *3 crops*	Hay *10 crops*
501W	RKbP	23.6	43.4	(1.05)
501E	RLKbP	26.0	40.3	(1.42)
502W	RK	20.8	35.6	(.62)
502E	RKL	21.1	35.8	(1.28)
503W	RKaP	22.5	43.8	(.68)
503E	RKLaP	23.7	34.5	(1.33)
504W	RKrP	20.3	43.4	(.68)
504E	RKLrP	25.5	39.6	(1.36)
505W	RK	16.3	32.0	(.52)
505E	RKL	21.8	39.0	(1.24)
506W	RKsP	20.5	41.9	(.78)
506E	RKLsP	25.2	47.4	(1.34)
	RKbP over RK	5.1	9.6	(.48)
	RKLbP over RKL	4.5	2.9	(.16)
	RKaP over RK	4.0	10.0	(.11)
	RKLaP over RKL	2.2	−2.9	(.07)
	RKrP over RK	1.8	9.6	(.11)
	RKLrP over RKL	4.0	2.2	(.10)
	RKsP over RK	2.0	8.1	(.21)
	RKLsP over RKL	3.7	10.0	(.08)

to the kind of crop produced. Considering first the results without limestone, we find the following order of efficiency: for corn—bone, acid, slag, rock; for oats—acid, either bone or rock, slag; and for hay—bone, slag, either acid or rock. Used with limestone, the relative efficiencies run as follows: for corn—bone, rock, slag, acid; for oats—slag, bone, rock, acid; and for hay—bone, rock, slag, acid. In general, the differences are small and a careful analysis of the data shows that most of them are to be considered insignificant, that is to say, well within the experimental error.

These results illustrate well the difficulty of laying down definite rules for practice in applying phosphorus fertilizer. To this point in the discussion there has been taken into account only the effect on production. When the economy from a financial standpoint is considered, the matter becomes even more complicated, for all depends upon relative cost of materials applied as well as upon the market value of produce sold, both of which are constantly fluctuating. However, with the data of Table 13, one may compute for himself the relative economy of producing these crop increases by applying any set of prices for crops and fertilizers which appear to be most applicable according to prevailing market conditions. In so doing, however, it should be constantly borne in mind that the order of efficiency might be easily shifted thru a relatively small change in commodity prices.

In 1922 these series were replotted and a different system of rotation established for further investigation of the various forms of phosphorus fertilizer. This later work, however, has not been under way long enough to warrant summarizing at this time.

In addition to the above described series, seven plots on the Odin field have been devoted to two special rotations featuring sweet clover. On three plots a rotation of corn, cowpeas or soybeans, and wheat has been practiced. Sweet clover has been seeded in both the corn and the wheat and plowed down as a green manure for the succeeding crop. On the other four plots the rotation has been corn, cowpeas or soybeans, wheat, and sweet clover. In this system the sweet clover has been allowed to make its second year's growth and produce a seed crop, the straw and chaff being returned to the land. Limestone and bone meal have been used in both these rotations.

The average annual crop yields of the two systems are compared in Table 14.

TABLE 14.—ODIN FIELD: USE OF SWEET CLOVER IN ROTATIONS
Average Annual Crop Yields—Bushels per acre

Rotation	Corn *19 crops*	Soybeans[1] *15 crops*	Wheat *19 crops*	Clover seed *18 crops*
Three-year	29.3	6.2	17.1	....
Four-year	35.8	9.2	22.2	1.56

[1]Or cowpeas.

The markedly higher production in all crops in the four-year rotation indicates the advantage of this system, in which one field out of four is devoted to the production of sweet clover, over the three-year system in which only catch crops of sweet clover are grown.

THE DUBOIS FIELD

Another experiment field on Gray Silt Loam On Tight Clay is located at DuBois in Washington county. This land lies practically level and appears to be uniform in soil type. The experiments were started in 1902. The field was laid off into a single series of plots having two sections, one tiled and the other untiled.

The rotation practiced the first eight years was corn, oats, and wheat followed by a legume. After two of these rotations the order was changed to corn, oats, clover, wheat, with a seeding of sweet clover and alsike on the residues plots for use as a green manure. Since there appeared to be little difference between the tiled and untiled sections, another change in cropping was made in 1922 by which corn is grown on one section and wheat with a seeding of sweet clover on the other.

Five tons of hydrated lime was applied in 1902, and no further application of lime was made until 1922, when 2 tons of limestone an acre was applied on the east section and 1,000 pounds an acre on the west section.

Until 1905 nitrogen was applied annually in approximately 650 pounds of dried blood an acre on what are now the residues plots; thereafter crop residues were substituted. Phosphorus was supplied in form of steamed bone meal applied at the rate of 200 pounds an acre a year, and potassium in 100 pounds of potassium sulfate an acre a year. In 1922 the applications of both phosphorus and potassium were discontinued temporarily.

A general summary of the annual crop yields is assembled in Table 15, and for convenience in studying the effect of the treatments the various possible comparisons are brought together in Table 16, where the results of the corresponding plots of the two sections are averaged and expressed in terms of crop increases. Some points of interest brought out by these comparisons are as follows:

Altho lime, as used in these experiments, has produced some increase in all crops, when applied alone it does not raise the plane of production sufficiently to give a profitable system of farming. In the presence of other fertilizing materials, however, its effectiveness is greatly enhanced.

The response to residues in the various combinations is rather complex. In some cases the increases to be ascribed to residues are marked. In the treatment with lime, phosphorus, and potassium, the effect of residues on the grain crops is quite indifferent, while on the hay crop it is very pronounced. In considering these residues results it should be noted that they include the data of the earlier years, when dried blood was used instead of crop residues to furnish nitrogen.

Phosphorus has given increases in all combinations in all crops, but the most significant effect produced was on the wheat. Potassium has produced a remarkable effect on the corn; in some cases the yields have been practically doubled following the potassium treatment. These results in general confirm those of the Odin field located on the same soil type, in that wheat responds in a notable way to phosphorus treatment while corn receives its greatest benefit from potassium treatment. A rational system of general farming designed to

TABLE 15.—DUBOIS FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1902-1923—Bushels or (tons) per acre

Plot No.[1]	Soil treatment applied[2]	Wheat	Corn	Oats	Clover		Soybeans
					Hay[3]	Seed	
		6 crops	*6 crops*	*5 crops*	*4 crops*	*2 crops*	*1 crop*
1	0.............	5.4	10.8	14.0	(.58)	......	3.5
2	L.............	9.7	13.0	23.0	(.61)	......	6.7
3	LR............	13.6	17.6	30.8	(.89)[3]	.80	7.2
4	LP............	20.7	17.1	35.2	(1.04)	......	8.5
5	LK............	16.7	25.9	30.8	(.89)	......	9.3
6	LRP...........	26.5	17.5	33.8	(1.17)[3]	1.88	8.2
7	LRK...........	19.7	25.2	32.9	(1.74)[3]	2.38	7.8
8	LPK...........	28.0	29.1	37.6	(1.67)	......	9.5
9	LRPK..........	27.0	28.8	34.8	(2.22)[3]	2.09	7.8
10	RPK...........	18.9	22.1	26.5	(2.00)[3]	2.09	6.3
11	0.............	6.3	11.7	14.3	(.54)	......	3.3
12	L.............	13.6	13.8	22.5	(.77)	......	6.2
13	LR............	16.2	16.4	28.0	(1.33)[3]	1.33	6.7
14	LP............	22.2	13.3	32.4	(1.14)	......	7.2
15	LK............	16.1	25.2	33.8	(1.23)	......	7.8
16	LRP...........	27.0	18.3	38.1	(2.11)[3]	2.42	8.8
17	LRK...........	23.3	29.7	32.4	(2.19)[3]	2.04	10.2
18	LPK...........	30.0	32.4	34.8	(1.88)	......	10.3
19	LRPK..........	28.0	30.8	33.1	(2.67)[3]	2.08	11.3
20	RPK...........	18.8	21.8	30.2	(2.41)[3]	2.25	6.7

[1]Plots 1 to 10 not tiled. Plots 11 to 20 tiled.
[2]Until 1905 dried blood was applied instead of residues.
[3]Only two crops of hay on Plots 3, 5, 7, 9, 10, 13, 16, 17, 19, and 20.

TABLE 16.—DUBOIS FIELD: EFFECT OF TREATMENT IN TERMS OF ANNUAL CROP INCREASES
Bushels or (tons) per acre

Comparison of treatments	Wheat *6 crops*	Corn *6 crops*	Oats *5 crops*	Clover hay[1] *2 or 4 crops*	Soybeans *1 crop*
Lime					
L over 0............	5.8	2.2	8.6	(.13)	3.1
LRPK over RPK....	8.7	7.9	5.6	(.24)	3.1
Residues					
LR over L..........	3.3	3.6	6.7	(.42)	.5
LRP over LP........	5.3	2.7	2.2	(.55)	.7
LRK over LK........	5.1	1.9	.4	(.91)	.5
LRPK over LPK....	−1.5	−1.0	−2.3	(.67)	−.4
Phosphorus					
LP over L..........	9.8	1.8	11.1	(.40)	1.4
LRP over LR........	11.9	.9	6.6	(.53)	1.6
LPK over LK........	12.6	5.2	3.9	(.72)	1.4
LRPK over LRK....	6.0	2.4	1.3	(.48)	.6
Potassium					
LK over L..........	4.8	12.2	9.6	(.37)	2.1
LRK over LR........	6.6	10.5	3.3	(.86)	2.1
LPK over LP........	7.6	15.6	2.4	(.69)	2.1
LRPK over LRP.....	.8	11.9	−2.0	(.81)	1.1

[1]Omitting any consideration of clover seed produced on certain plots.

bring this land into the highest production of which it is capable calls for the application of both these elements of plant food to be used in conjunction with limestone and organic manures.

The marked benefit to wheat and the indifferent response of all other crops following the use of bone meal suggest that in practice perhaps phosphorus could be supplied more economically by using somewhat smaller quantities of phosphatic fertilizer and applying it directly to the wheat crop. Likewise, it seems probable, judging from the relative crop responses to potassium treatment, that the expense of potassium fertilizer might be reduced by cutting down the quantity used in these tests, applying the material direct to the corn crop. The organic manures are well furnished by crop residues and legumes plowed down but, under some circumstances, at least a part of the legumes and crop residues will be utilized advantageously by pasturing or feeding them to livestock, the manure produced therefrom to be carefully conserved and regularly returned to the land.

THE ALHAMBRA FIELD

As representing field experiments on Brown-Gray Silt Loam On Tight Clay, the results of the Alhambra experiment field are presented. This field, located in Madison county near Alhambra, was established in 1918. It is devoted primarily to crop investigations, but the work on certain plots is so planned as to show the effect of soil treatment.

The land is flat and portions of it are practically level. On half of the field tile drainage has been provided, but owing to the impervious nature of the subsoil the effect has not been satisfactory. A crop rotation of corn, oats, mammoth clover, and wheat seeded with sweet clover for green manure, has been practiced. The land is managed as under the grain system of farming, no animal manure being employed. All plots except certain checks receive limestone and rock phosphate in addition to the residues treatment.

The effects of the soil treatments are presented in Table 17, which gives a summary of the annual crop yields obtained during the time the plots have been under their complete treatments.

So far as crop yields indicate, there is little evidence to show the advantage of tiling. Excepting the clover, all crops appear to have received some benefit from the combination of limestone and rock phosphate. However, under present market conditions the gains would scarcely be sufficient to return a financial profit. The response to rock phosphate without limestone is irregular. The wheat shows an increase in both tiled and untiled sections, but the corn and oats

TABLE 17.—ALHAMBRA FIELD: SUMMARY OF CROP YIELDS
Average annual yields 1919-1924—Bushels or (tons) per acre

Soil treatment	Wheat *5 crops*		Corn *5 crops*		Oats *4 crops*		Clover *1 crop*		Soybeans *3 crops*	
	Tiled	Untiled	Tiled	Untiled	Tiled	Untiled	Tiled	Untiled	Tiled	Untiled
R	20.4	19.2	19.9	20.2	19.4	19.3	.53	.72	19.7	20.0
RP	23.1	22.6	24.2	18.5	24.1	17.9	.58	.59	18.4	19.2
RLP	23.1	24.3	32.3	26.3	25.5	25.4	.50	.63	21.7	22.5

show increases on the tiled plots only. There is no test of limestone without phosphate on this field.

THE PANA FIELD—SERIES 400 AND 500

The Pana field, located at Pana in Christian county, lies partly on the soil type Brown-Gray Silt Loam On Tight Clay. With the exception of two small spots all plots on Series 400 and 500, situated on the east end of the field, are located on this type.

The Pana field was laid out in 1912. During the first ten years the 400 and 500 series were parts of a five-series system under a rotation of corn, oats, clover, wheat, and alfalfa. In 1922 two independent rotations were established by which the 400 and 500 series were combined with the 300 series and brought under a three-year rotation of corn, oats, and wheat. The several crops produced, together with the plot treatments, are shown in Table 18. The average annual yields are given in this table, and the various possible comparisons of soil treatments are brought together in Table 19, where the results are expressed in terms of crop increase. The following observations may be made, making full allowance for a rather large experimental error due to the small numbers of crops represented.

Manure, used alone, has had little effect aside from that on the wheat, where an increase of nearly 5 bushels is shown. Residues, alone, have given practically the same increase in wheat as has manure and they have likewise improved the corn yields.

Limestone is the outstanding treatment on this field. With few exceptions, all crops show a decided improvement following the use of limestone, and many of the crop increases are very pronounced. The alfalfa especially was greatly benefited by it.

Phosphorus, applied in the form of rock phosphate, proved consistently beneficial to the wheat crop but, in general, other crops have not responded in a profitable manner to this treatment.

Potassium, applied in the form of kainit, appears in these experiments in but a single combination. In most of the crops the differences are not significant. In fact, several of the figures carry the minus sign, so that upon the basis of these experiments the conclusion is that potassium is not needed on this soil.

By the term "cover crop," as used in these experiments, is meant the practice of seeding a legume catch crop in the wheat, and in some instances in the corn, to be plowed down in preparation for the crop that follows. Cover crops in the three combinations tested give conflicting results. Used with manure alone, the increases in crop yield are considerable, but with limestone in addition to manure these gains are greatly reduced.

The results on the whole support the recommendation that limestone and organic manures be used for building up this land. If wheat is grown, phosphorus fertilization is likely to be profitable; otherwise a financial return sufficient to cover expenditure appears to be doubtful.

TABLE 18.—PANA FIELD, SERIES 400 AND 500: SUMMARY OF CROP YIELDS, 1914-1922

Bushels or (tons) per acre

Plot No.	Soil treatment	Corn *4 crops*	Oats *3 crops*	Wheat *3 crops*	Alfalfa *3 crops*	Clover *1 crop*	Soybeans[1] *2 crops*
401	0	22.1	34.6	13.4	(.95)	(1.01)	9.7
402	M	20.3	41.8	17.9	(1.04)	(1.40)	9.5
403	ML	27.6	52.1	27.7	(3.19)	(2.44)	12.5
404	MLP	32.3	49.3	29.9	(3.36)	(2.38)	12.3
405	0	19.7	43.5	13.4	(1.28)	1.58	10.3
406	R	27.5	40.7	17.8	(1.39)	2.25	9.6
407	RL	34.4	53.1	29.6	(3.09)	2.42	15.3
408	RLP	37.2	56.2	35.9	(3.65)	2.08	12.3
409	RLPK	32.3	57.6	31.8	(3.76)	2.00	14.0
410	0	27.6	49.5	14.4	(1.59)	(2.27)	12.7
411	CvM	30.0	58.0	19.0	(1.66)	(2.21)	13.7
412	CvML	32.2	49.7	26.5	(3.19)	(2.66)	17.0
413	CvMLP	35.4	54.5	29.9	(3.10)	(2.51)	13.3
414	CvMP	27.2	52.3	24.4	(.89)	(2.14)	11.3
415	0	20.8	42.3	12.6	(.56)	(1.82)	9.6
416	0	19.4	39.3	11.6	(.64)	(1.54)	9.0

[1]On manure plots one crop was harvested as hay but evaluated as seed in this average.

TABLE 19.—PANA FIELD, SERIES 400 AND 500: EFFECT OF TREATMENTS IN TERMS OF ANNUAL CROP INCREASES

Bushels or (tons) per acre

Comparison of treatments	Corn *4 crops*	Oats *3 crops*	Wheat *3 crops*	Alfalfa *3 crops*	Clover *1 crop*	Soybeans *2 crops*
Manure						
M over 0	1.6	0.0	4.8	(.04)	−.24	−.8
Residues						
R over 0	5.6	−1.1	4.7	(.39)	....	−.7
Limestone						
L over M	7.3	10.3	9.8	(2.15)	(1.04)	3.0
L over R	6.9	12.4	11.8	(1.70)	.17	5.7
LCvM over CvM	2.2	−8.3	7.5	(1.53)	(.45)	3.3
LCvMP over CvMP	8.2	2.2	5.5	(2.21)	(.37)	2.0
Phosphorus						
PML over ML	4.7	−2.8	2.2	(.17)	(−.06)	−.2
PCvML over CvML	3.2	4.8	3.4	(−.09)	(−.15)	−3.7
PCvM over CvM	−2.8	−5.7	5.4	(−.77)	(−.07)	−2.4
PRL over RL	2.8	3.1	6.3	(.56)	−.34	−3.0
Potassium						
RLPK over RLP	−4.9	1.4	−4.1	(.11)	−.08	1.7
Cover Crop						
CvM over M	9.7	16.2	1.1	(.62)	(.81)	4.2
CvML over ML	4.6	−2.4	−1.2	(0.00)	(.22)	4.5
CvMLP over MLP	3.1	5.2	0.0	(−.26)	(.13)	1.0

THE ELIZABETHTOWN FIELD

The Elizabethtown experiment field was established by the University in 1917, in the unglaciated hilly section of southern Illinois. This field is located in Hardin county about two miles north of Elizabethtown. The soil is of loessial formation, the predominating type on this field being classified as Yellow Silt

Loam. A detailed examination, however, shows the presence of some Yellow-Gray Silt Loam and also a very small patch of Stony Loam. The land is extremely rough in topography, the contour map showing a range in elevation of 42 feet on that part of the field occupied by the present plots. Erosion, therefore, is a serious problem. The field embraces about 32 acres, of which area about one-half is laid off into plots. There are four series of 10 fifth-acre plots each, included in a major rotation. Another series of 10 tenth-acre plots is devoted to another rotation, and in addition to these there are three other plots designated as A, B, and C, upon which a special phosphate test is being carried on.

The major rotation formerly included corn (with rye cover crop), soybeans, wheat, and sweet clover, but this was changed in 1923 to a rotation of corn, wheat, clover-timothy mixture, and wheat with sweet clover seeding on the residue plots. The plot treatments are indicated in the following table of results. The difficulty of obtaining satisfactory experimental data on land of such rough topography is obvious. There are, however, certain effects standing out in such bold relief as to leave no doubt as to their significance. The results for the different crops are summarized in Table 20, showing the yields since full treatment has been in force.

These results show extremely poor yields on the untreated land, with no improvement from the use of manure alone or residues alone. A sharp increase in yield, however, follows the application of limestone along with either manure or residues. Rock phosphate seems to have produced a beneficial effect on the corn, on the wheat following legumes, and on the timothy-clover mixture, in both the manure and the residues systems. The potassium treatment as applied in these experiments does not show sufficient benefit to cover the cost. The following general observations are of interest. The wheat following legumes has a much more favorable place in the rotation than the wheat following corn, which fact is manifested by the relative yields. Soybeans have not proved a very successful crop on this field. It is of interest to note that the residues system appears to be fully as effective in building up this soil as the manure system, but a rational system of farming might well include livestock, in which the manure as well as all available crop residues would be utilized for soil improvement.

TABLE 20.—ELIZABETHTOWN FIELD: SUMMARY OF CROPS GROWN
Average Annual Yields 1919-1924—Bushels or (tons) per acre

Soil treatment	Corn *6 crops*	Wheat following legumes *4 crops*	Wheat following corn *2 crops*	Timothy clover mixture *2 crops*	Soybeans *3 crops*	Sweet clover seed *2 crops*
0	21.4	6.9	5.0	(0.00)	2.7	0.00
M	20.4	6.5	4.4	(0.00)	3.1	0.00
ML	33.5	11.1	10.2	(.90)	4.2	2.59
MLP	38.8	15.4	9.0	(1.45)	5.2	2.42
0	14.5	6.9	2.4	(0.00)	2.3	0.00
R	15.7	6.1	2.9	(0.00)	2.5	0.00
RL	31.8	11.6	4.9	(1.02)	4.3	1.99
RLP	41.3	15.7	5.2	(1.20)	5.0	1.74
RLPK	40.7	16.6	4.9	(1.44)	4.6	1.49
0	22.5	7.3	4.4	(0.00)	3.0	0.00

The results from the minor rotation on Series 500 are too few to warrant consideration at this time.

On Plots A, B, and C a comparison of the two carriers of phosphorus, acid phosphate and rock phosphate, is under way. The acid phosphate is applied at the rate of 200 pounds an acre a year and the rock phosphate in double this quantity.

In a rotation of corn, cowpeas, and wheat, four crops of corn, three of cowpeas, and three of wheat can be compared at this time. It is of interest to note the results that thus far have been obtained, bearing in mind that the data are not sufficient to warrant drawing final conclusions as to which carrier of phosphorus will prove to be the more economical to use. Table 21 presents the crop yields from these comparative phosphate tests covering the period since the full soil treatment has been appiled.

TABLE 21.—ELIZABETHTOWN FIELD: COMPARATIVE TEST OF ACID PHOSPHATE AND ROCK PHOSPHATE
Annual Acre Yields of Crops Grown, 1921-1924—Bushels per acre

Year	Corn		Wheat		Cowpeas	
	Acid phosphate	Rock phosphate	Acid phosphate	Rock phosphate	Acid phosphate	Rock phosphate
1921......	28.8	28.6	....	....	9.2	7.8
1922......	34.4	32.0	3.2	9.8	12.5	4.7
1923......	32.2	46.8	18.6	14.3	10.5	9.2
1924......	54.6	59.2	13.3	8.8	....	....
Average...	37.5	41.7	11.7	11.0	10.7	7.2

On the whole, the differences shown in the averages are relatively small, so that it may be said that after four years the data furnish no reliable indication as to which form of phosphate is the more effective on this field in increasing crop yields.

THE OLD VIENNA FIELD

From 1902 to 1911 the University conducted an experiment field in Johnson county, about two miles southeast of Vienna, on land that was described at the time as "red clay, a soil typical of the hill sections of the state." The soil is characteristic of much of the type designated as Yellow Silt Loam. The field comprized a tract of 5.6 acres of land rolling in topography, a portion of which was low and wet. It was not tile-drained.

Previous to 1902 this land had been cultivated for about fifty years, after which it was said to be still capable of producing fair crops of corn and wheat.

For the experiment work the field was laid out into three series of plots one-fifth acre in size, each series containing 5 plots. A crop rotation of wheat, corn, and cowpeas was started; but in 1905 this rotation was changed to corn, oats, wheat, and legumes. Cowpeas for plowing down were seeded in the corn at the last cultivation excepting on Plot 1. As the carrier of phosphorus, steamed bone meal was used at the rate of 200 pounds an acre a year. Potassium was applied in the form of potassium sulfate, this material being used at the annual acre rate of 100 pounds. Lime was applied in 1902 in the form of slaked lime at the rate of 1,800 pounds, and the following year limestone was added at the rate of 8 tons an acre.

Table 22 presents a summary giving the average annual acre yields of the 9 corn crops and 8 wheat crops harvested after the plots had received their respective treatments.

The great need of this land for organic matter and nitrogen is brought out in these results. Organic matter and nitrogen are furnished by the legumes in these experiments; but in order to produce a thrifty growth of legumes, it was

TABLE 22.—OLD VIENNA FIELD: SUMMARY OF THE GRAIN CROPS
Average Annual Yields 1903-1911—Bushels per acre

Soil treatment	Corn *9 crops*	Wheat *8 crops*
0	29.0	3.0
Le	29.8	5.7
LeL	39.7	10.9
LeLP	37.5	13.6
LeLPK	40.7	15.6

necessary to apply lime. Thus, upon the addition of limestone, the corn yield was increased by one-third, while the wheat yield was practically doubled. In the case of the corn, little or no effect was produced by the addition of either phosphorus or potassium treatment. In the wheat, however, an increase of about 3 bushels an acre a year appears upon the addition of phosphorus, and a further increase of 2 bushels an acre a year upon including potassium in the treatment.

The yields from the three clover crops are not summarized here but it may be stated that some very fair yields of clover were obtained on the better treated plots.

Altho these results furnish an indication of the most important needs of this land, it cannot be said that the experiments as conducted represent directly an economical system of farming. Considering the several years in which the land was given over to the growth of a green manure crop when nothing was harvested, even the yields from the best plots would scarcely be sufficient to cover the cost of maintenance. However, it appears possible that by modifying the cropping plan in some manner, as for example, substituting sweet clover for cowpeas and giving large place in the farming system to hay and pasture crops, production might be substantially increased and thus a system of farming instituted that would represent a profitable enterprise.

THE NEW VIENNA FIELD

From 1906 to 1924 another experiment field, designated as the new Vienna field, was maintained. This field was located about a mile southeast of Vienna and about a half-mile west of the old Vienna field described above. It embraced 16 acres of the badly eroded, hilly land characteristic of the region.

The soil of this field is, in general, of loessial formation. It is strongly acid in reaction. Altho the soil type appears on the county map as Yellow Silt Loam, a detailed examination of the area occupied by the field discloses on a larger-scale map three separable types, namely, Yellow Silt Loam, Yellow-Gray Silt Loam, and Deep Gray Silt Loam.

The work on this field from 1906 to 1915 was concerned with an investigation of methods of reclaiming this land primarily thru means of reducing erosion. Before taking over the field, the land, with the exception of about three acres, had been abandoned because so much of the surface soil had been washed away, and gulleying had become so bad that further cultivation was unprofitable. Some of the gulleys were four or five feet deep, so that the first step in reclaiming the land was to fill them and thus make the slopes more uniform.

The field was divided into five sections. The sections designated as A, B, and C were divided into 4 plots each, and D into 3 plots. On Section A, which included the steepest part of the area and contained many gullies, the land was built up into terraces at vertical intervals of five feet. Near the edge of each terrace a small ditch was placed so that the water could be carried to a natural outlet without much washing.

On Section B the so-called embankment method was used. By this method erosion is prevented by plowing up ridges sufficiently high so that if the water breaks over, it will run over in a broad sheet rather than in rills thru narrow channels. At the steepest part of the slope, hillside ditches were made for carrying away the run-off.

Section C was washed badly but contained only small gullies. Here the attempt was made to prevent washing by incorporating organic matter in the soil and practicing deep contour plowing and contour planting. With two exceptions, about eight loads of manure an acre were turned under each year for the corn crop.

The land on Section D was washed to about the same extent as that of Section C. As a check on the different methods of reducing erosion, the land on Section D was farmed in the most convenient way, without any special effort being made to prevent washing.

Section E was badly eroded and gullied and no attempt was made to crop it other than to fill in the gullies with brush and to seed the land to grass.

Sections A, B, C, and D were not entirely uniform; some parts were washed more than others and portions of the lower-lying land had been affected by soil material washed down from above. When the field was secured, the higher land had a very low producing capacity. On many spots little or nothing would grow.

Limestone was applied to the entire field at the rate of 2 tons an acre. Corn, cowpeas, wheat, and clover were grown in a four-year rotation on each section excepting D which had but three plots.

Table 23 contains a summarized statement of the results obtained. For a more detailed account of this work the reader is referred to Bulletin 207 of this Station entitled "Washing of Soils and Methods of Prevention."

These results indicate something of the possibilities in improving hillside land by protecting it from erosion. The average yield of corn from the protected sections (A, B, and C) was 30.6 bushels an acre, as against 14.1 bushels for Section D; wheat yielded 11.1 bushels in comparison with 4.6 bushels; and clover .82 ton in comparison with .21 ton.

A comparison of Figs. 5 and 6 will serve to indicate the possibility of improving this type of soil.

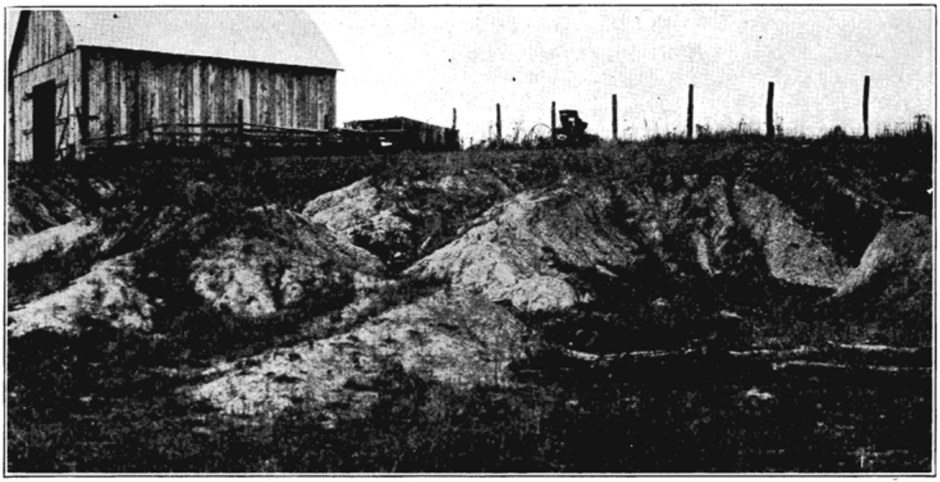

FIG. 5.—VIEW OF AN UNIMPROVED HILLSIDE OVER THE FENCE FROM THE FIELD SHOWN IN FIG. 6.

TABLE 23.—NEW VIENNA FIELD: HANDLING HILLSIDE LAND TO PREVENT EROSION
Average Annual Yields 1907-1915—Bushels or (tons) per acre

Section	Method	Corn *7 crops*	Wheat *7 crops*	Clover *3 crops*
A	Terrace	31.4	9.0	(.68)
B	Embankments and hillside ditches	32.4	12.7	(.97)
C	Organic matter, deep contour plowing, and contour planting	27.9	11.7	(.80)
D	Check	14.1	4.6	(.21)

FIG. 6.—CORN GROWING ON IMPROVED HILLSIDE OF THE VIENNA EXPERIMENT FIELD. THIS LAND FORMERLY HAD BEEN BADLY ERODED. COMPARE WITH FIG. 5.

List of Soil Reports Published

1	Clay, 1911	17	Kane, 1917
2	Moultrie, 1911	18	Champaign, 1918
3	Hardin, 1912	19	Peoria, 1921
4	Sangamon, 1912	20	Bureau, 1921
5	LaSalle, 1913	21	McHenry, 1921
6	Knox, 1913	22	Iroquois, 1922
7	McDonough, 1913	23	DeKalb, 1922
8	Bond, 1913	24	Adams, 1922
9	Lake, 1915	25	Livingston, 1923
10	McLean, 1915	26	Grundy, 1924
11	Pike, 1915	27	Hancock, 1924
12	Winnebago, 1916	28	Mason, 1924
13	Kankakee, 1916	29	Mercer, 1925
14	Tazewell, 1916	30	Johnson, 1925
15	Edgar, 1917	31	Rock Island, 1925
16	DuPage, 1917	32	Randolph, 1925

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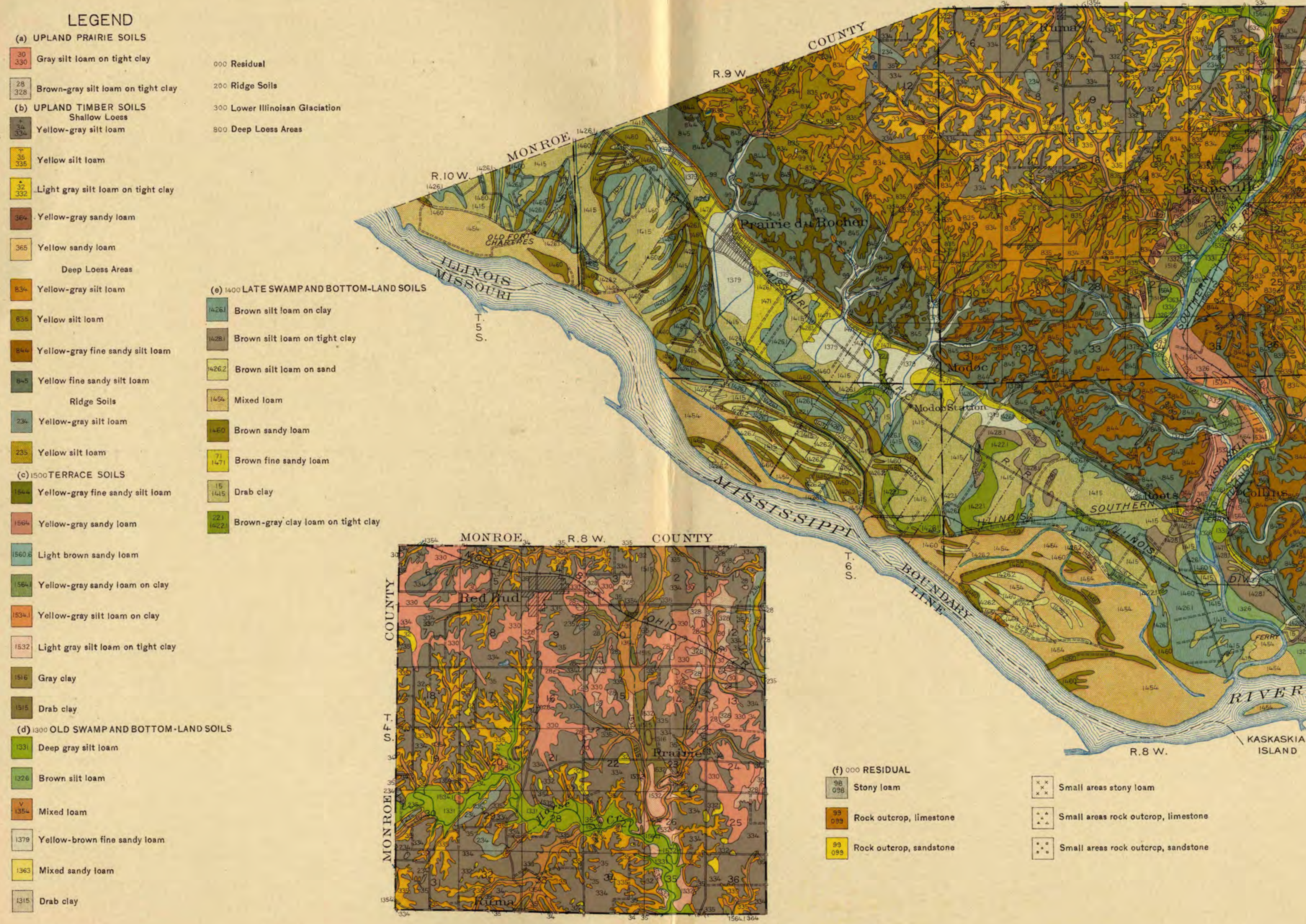
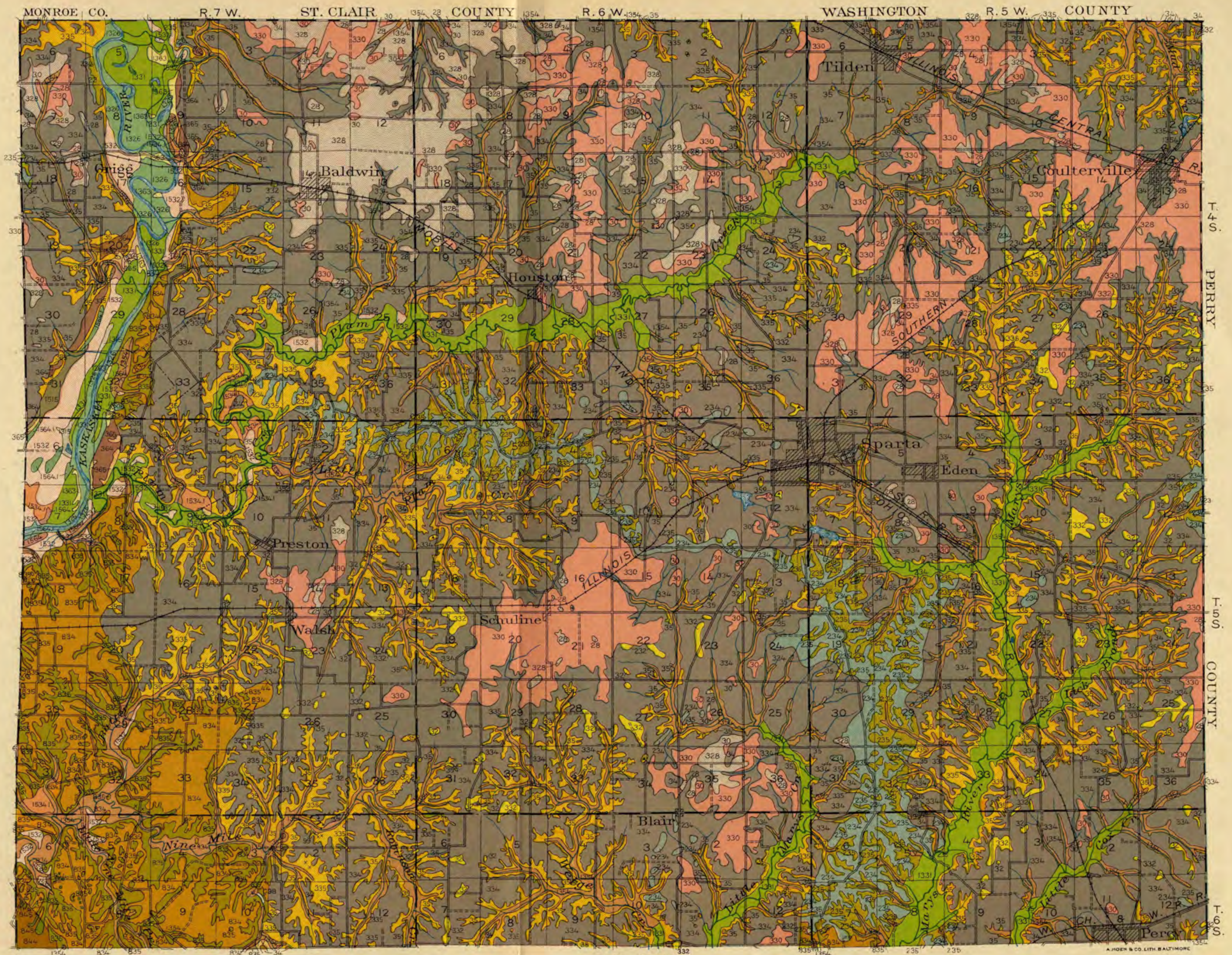


SOIL SURVEY MAP OF RANDOLPH COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

Scale
0 1/4 1/2 1 2 Miles

A. HOEN & CO. LITH. BALTIMORE



LEGEND

000 Residual

200 Ridge Soils

300 Lower Illinoisan Glaciation

800 Deep Loess Areas

(a) UPLAND PRAIRIE SOILS

- 30 / 330 Gray silt loam on tight clay
- 28 / 328 Brown-gray silt loam on tight clay

(b) UPLAND TIMBER SOILS

Shallow Loess

- 34 / 334 Yellow-gray silt loam
- 35 / 335 Yellow silt loam
- 32 / 332 Light gray silt loam on tight clay
- 364 Yellow-gray sandy loam
- 365 Yellow sandy loam

Deep Loess

- 834 Yellow-gray silt loam
- 835 Yellow silt loam
- 844 Yellow-gray fine sandy silt loam
- 845 Yellow fine sandy silt loam

Ridge Soils

- 234 Yellow-gray silt loam
- 235 Yellow silt loam

(c) 1500 TERRACE SOILS

- 1544 Yellow-gray fine sandy silt loam
- 1564 Yellow-gray sandy loam
- 1560.8 Light brown sandy loam
- 1564 Yellow-gray sandy loam on clay
- 1534.1 Yellow-gray silt loam on clay
- 1532 Light gray silt loam on tight clay
- 1516 Gray clay
- 1515 Drab clay

(d) 1300 OLD SWAMP AND BOTTOM-LAND SOILS

- 1331 Deep gray silt loam
- 1326 Brown silt loam
- 1354 Mixed loam
- 1379 Yellow-brown fine sandy loam
- 1363 Mixed sandy loam
- 1315 Drab clay

(e) 1400 LATE SWAMP AND BOTTOM-LAND SOILS

- 1426.1 Brown silt loam on clay
- 1428.1 Brown silt loam on tight clay
- 1426.2 Brown silt loam on sand
- 1454 Mixed loam
- 1460 Brown sandy loam
- 1471 Brown fine sandy loam
- 1422.1 Brown-gray clay loam on tight clay
- 1415 Drab clay

(f) 000 RESIDUAL

- 098 Stony loam
- 099 Rock outcrop, limestone
- 099 Rock outcrop, sandstone
- Small areas stony loam
- Small areas rock outcrop, limestone
- Small areas rock outcrop, sandstone

Scale 0 ¼ ½ 1 2 Miles

SOIL SURVEY MAP OF RANDOLPH COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

SOIL SURVEY MAP OF RANDOLPH COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION